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Case Studies of Stationary Source Compliance with North Carolina Air Pollution Control Requirements

Booz-Allen and Hamilton, Inc.
Bethesda, MD

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CEQ and EPA sponsored five studies examining the response of sources to the regulatory approach to controlling air pollution, with emphasis on the post-compliance emissions history. The study areas are: North Carolina (3 vols), Houston (3 vols), San Diego (3 vols), Chicago (3 vols), and New Jersey (2 vols).

This report on Task II presents the results of 20 plant inspections conducted in North Carolina. One of the principal purposes of the plant inspections was to evaluate the effectiveness of EPA regulatory policies with respect to the operation and maintenance of the control equipment. Potential benefits of proposed regulatory modifications are considered.

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Case Studies of Stationary Source Compliance with North Carolina Air Pollution Control Requirements

JULY 1, 1979

PREPARED FOR

PRESIDENT'S COUNCIL ON ENVIRONMENTAL QUALITY

OFFICE OF PLANNING AND EVALUATION
U.S. ENVIRONMENTAL PROTECTION AGENCY

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July 3, 1979

Mr. James S. Vickery
Office of Planning and Evaluation
Room 1019-B (West Tower)
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Jim:

We are pleased to submit our final Task II report for the North Carolina case study entitled "Case Studies of Stationary Source Compliance with North Carolina Air Pollution Control Requirements." Principal contributors to the report were John Richards and Tom Mappes of PEDCo Environmental.

In preparing the report, we took into consideration the comments you and Gordon had on our draft report.

We will be available to answer any questions you may have and hope to be able to assist you in the future.

Sincerely,

Alan L. Farkas

BOOZ·ALLEN & HAMILTON Inc.

Alan L. Farkas
Principal

EXECUTIVE SUMMARY

The Council of Environmental Quality and the United States Environmental Protection Agency have sponsored a set of four concurrent studies in different geographical regions, concerning the performance of air pollution control systems in the post-compliance period. This report presents the results of 20 plant inspections conducted in North Carolina. One of the principal purposes of the plant inspections was to evaluate the effectiveness of the Agency regulatory policies with respect to the operation and maintenance of the control equipment. Potential benefits of proposed regulatory program modifications are considered.

The voluntary cooperation policy adopted by the State of North Carolina appears to be reasonably effective. The field inspectors have generally been able to establish relationships of mutual respect with the source operators, and this facilitates the expeditious repair of system malfunctions. Increased technical and economic support of the field inspector could improve the program even more.

Excess emissions problems were identified at nine of the cases studied. Five of these sources account for 98% of the total quantity. As a group of twenty sources, the total excess emissions appear to be a significant fraction of the allowable emissions. However, in a number of cases, the sources actually emitted considerably less than allowed. This reflects good design and good operation/maintenance practices. A term called "emission credits" has been defined so that these sources can be properly recognized.

Design deficiencies appear to be the principal cause of the excess emission problems evaluated in this study. These deficiencies include undersizing of control equipment, lack of proper instrumentation, and improper selection of materials of construction. Many of these problems could have been identified in a more aggressive new source permit review program.

More comprehensive plant inspection procedures would have been effective in reducing the quantity of excess emissions. In two of the cases, improved agency review could conceivably have prevented the complete failure of control devices and thereby saved the sources the cost of replacement units.

ACKNOWLEDGEMENTS

This report was prepared for Booz, Allen & Hamilton. PEDCo Environmental sincerely appreciates the assistance and guidance provided by Mr. Alan Farkas and Dr. Joanne Wyman of Booz, Allen & Hamilton. Appreciation is also expressed to the industry personnel and North Carolina Air Quality Section personnel who provided information and assistance in this project.

The PEDCo project director was Mr. Tim Devitt. The project manager of the combined North Carolina and Houston, Texas studies was Dr. Gerald Isaacs. The project manager of the North Carolina study was Mr. John Richards.

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1. IDENTIFICATION OF STATIONARY SOURCE CASE STUDIES

Procedures used in the selection of stationary sources evaluated in the study are described in this section. The basic selection criteria issued by the Council of Environmental Quality (CEQ) and the United States Environmental Protection Agency (USEPA) are presented in order to indicate the desired source characteristics. Due to the inherent characteristics of air pollution sources in North Carolina, it was not possible to exactly match these criteria as proposed. The basic procedures used to identify the candidate sources and to select the final group of 20 are presented.

1.1 SELECTION CRITERIA

CEQ and EPA, as joint sponsors of the project, have proposed an extensive list of criteria (Table 1-1) to be used in the selection of stationary sources. In addition to fulfilling these requirements, half of the group must have achieved compliance at one time and had subsequent difficulty in maintaining compliance. The remaining half of the group was to be chosen randomly.

These selection criteria impose a large number of constraints on a population of only 20 sources. PEDCo has attempted to emphasize the most important items of Table 1-1, which we perceive to be (1) the availability of useful data - item 2, (2) the distribution of source types - item 6, (3) the distribution on potential uncontrolled emissions - item 4, (5) the distribution of control techniques - item 9a, and (5) the types of pollutants emitted - item 1. Compilation of an acceptable list of candidate sources was challenging.

The scope of the study was limited to the 16 industrial categories listed in Table 1-2. The approximate number of such sources in North Carolina is presented, based on the estimates of North Carolina Air Quality Section personnel.

This study was limited to the geographical areas under the direct jurisdiction of the State. Thus, though most of the hydrocarbon and several sulfur dioxide sources are located in Mecklenburg and Forsyth Counties, they were not included since responsibility for these areas has been delegated to the Counties.

Table 1-1. CEQ/EPA SOURCE SELECTION CRITERIA

1. Nearly equal distribution of sources of following pollutants: TSP, SO_x, HC.
2. All sources are data rich, i.e., have hard emission data available.
3. All sources are willing to participate in study.
4. Nearly equal distribution of sources according to uncontrolled emission levels in excess of 25 TPY.
5. Nearly equal distribution of sources according to size of operation, but employing no fewer than 50 people.
6. Nearly equal distribution of sources from categories on identification list (see Table 1-2).
7. Nearly equal distribution of sources according to ages of process and control system equipment.
8. Nearly equal distribution of sources according to types of corporate structure, i.e., publicly held corporation, private corporation, publicly owned utility.
9. Consideration for maximizing the variation in:
    a) Types of control systems to be studied,
    b) Levels of required control, i.e., collection efficiency, and
    c) Levels of capital and operating costs in order to achieve desired control.

Table 1-2. NUMBER OF REGISTERED SOURCES AVAILABLE FOR STUDY IN NORTH CAROLINA

	Source Categories	Approximate Number of Sources
1.	Steam Generating Plants (Utility and Industrial)	>15
2.	Pulp and Paper Mills	7
3.	Incinerators	>8
4.	Petroleum Products and Handling	undetermined
5.	Cement Plants	1
6.	Asphalt Plants	>200
7.	Mineral Acid Plants	6
8.	Iron and Steel Plants	12
9.	Aluminum Plants	1
10.	Brass and Bronze Plants	0
11.	Petrochemical Plants	10-12
12.	Stone, Clay and Glass Plants	>80
13.	Grain Handling Operations	6
14.	Fertilizer Plants	1
15.	Lumber and Wood Products Plants	>300
16.	Surface Coating Operations	unknown
	Total Registered Sources (All Categories)	931
	Estimated Total Sources (Registered & Unregistered)	4,000-20,000

1.2 Selection Procedures

Sources were selected for study based on the recommendations of State agency personnel and on a review of the central files. A chronology of the selection process is provided to describe the considerable effort devoted to the selection process.

On August 10-11, 1978 a meeting was held with Mr. David Ligon of the North Carolina Air Quality Section. After a brief discussion of the CEQ/EPA criteria, Mr. Ligon provided a list of 30 sources of possible interest. This list was carefully reviewed with respect to the items of Tables 1-1 and 1-2, then the central files concerning these plants were reviewed. Time requirements for the file reviews averaged 1 to 2 hours. A preliminary list of 19 sources was selected out of the group of 30 initially provided. Mr. Ligon recommended that PEDCo contact Mr. Derr Leonhardt of his staff for additional suggestions. During a meeting with Mr. Leonhardt on August 18th, a list of 20 additional sources was provided. After review of the appropriate files, 14 of these were added to the preliminary list giving a total of 33 sources.

The preliminary list was refined in several meetings and telephone contacts with regional engineers. On August 22th, a meeting was held with Mr. M. Rackley and his staff concerning sources within the North Central Region. They suggested several alternative sources that were experiencing continuous compliance problems. The preliminary list was revised accordingly. Similar assistance was provided by Mr. R. Haines of the South Piedmont Office during an August 28th telephone conversation. On August 29th, a meeting was held with Mr. Ligon and representatives of all seven regions. The importance of identifying data rich sources was again emphasized, and recommendations for changes were solicited.

The preliminary source list was submitted to Booz, Allen & Hamilton for review and several revisions were made.

At PEDCo's request, North Carolina regional engineers contacted the sources on the final list to obtain approval to visit the plants; only one company declined to participate.

The final list of sources included in the study is characterized in Table 1-3. The source number shown in the left margin is a randomly assigned identification code which is used to prevent disclosures of company names. The source category code listed in column 2 corresponds to those listed in Table 1-2. The principal pollutants subject to State regulations are listed in the third column. In most cases there are a number of other pollutants emitted from these sources which are not subject to North Carolina regulations. The generic type of control technique is listed in the fourth column. It is apparent that a wide variety of devices have been included in the study. There is also considerable diversity in the sizes of the equipment and the potential uncontrolled emissions.

Most of the control devices presently operating in North Carolina have been installed in the last eight years. This is due primarily to the promulgation of more stringent regulations which preclude the previous practice of using efficiency cyclones and settling chambers. There are few wet scrubbers, fabric filters, and electrostatic precipitators that are more than 5 years old. In this study there is an unavoidable bias toward sources with control equipment in the age range of 3 to 8 years.

1.3 SPECIAL ISSUES

Due partly to the exclusion of two heavily industrialized counties and partly to the general characteristics of North Carolina industry, there were a limited number of sources available for study in some of the source categories listed in Table 1-2. It is apparent that cement plants, primary and secondary aluminum plants, and brass and bronze

Table 1-3. CHARACTERISTICS OF STATIONARY SOURCES INCLUDED IN STUDY

Source Number	Industry Type	Principal Pollutant	Control Device and Age (Yrs.)	Gas Flow Rate (SCFM)	Uncontrolled Emissions (Tons/Year)
1	1	Part.	ESP (4)	4.0×10^6	2.6×10^5
2	12	Part.	Scrubber (6)	9.0×10^3	5.0×10^2
3	14	Part.	Baghouse (2)	3.6×10^4	4.0×10^3
4	15	Part.	Baghouse (4)	3.4×10^4	6.5×10^2
5	1	Part.	ESP (4)	5.5×10^5	3.2×10^4
6	2	Part.	ESP (2)	5.4×10^5	2.0×10^5
7	8	Part.	Scrubber (2)	4.0×10^4	3.0×10^2
8	2	Part.	ESP (2)	5.0×10^5	3.8×10^4
9	12	Part.	Scrubber (2)	2.0×10^4	4.2×10^2
10	16	HC	Carbon Adsorber (2)	3.0×10^4	1.4×10^3
11	6	Part.	Baghouse (2)	3.0×10^4	6.3×10^3
12	16	HC	Carbon Adsorber (5)	1.0×10^4	2.0×10^3
13	16	Part.	ESP (3)	1.1×10^4	2.1×10^2
14	12	Part.	Baghouse (25)	2.4×10^4	8.1×10^2
15	1	Part.	Scrubber (3)	2.5×10^4	8.4×10^2
16	2	Part.	Scrubber (2)	3.3×10^4	2.7×10^4
17	16	Part.	Incinerator (1)	5.0×10^3	Unknown
18	12	Part.	Scrubber (6)	1.5×10^4	3.1×10^2
19	15	Part.	Baghouse (4)	9.5×10^3	6.5×10^2
20	14	Part.	Scrubber (6)	6.0×10^3	9.7×10^1

smelters are not well represented in the State. We were unable to identify any plant in these three industrial categories that satisfied the selection criteria.

The population of sources available for study is further reduced by the lack of air pollution control devices at many North Carolina plants. In many cases, sources have been able to comply with applicable regulations by process modification or fuel changes. For example, there are presently no flue gas desulfurization systems for SO2 control at coal-fired boilers, and there are no fabric filters for particulate control at glass plants. Many of the hydrocarbon sources have achieved compliance by the use of nonphotochemically active solvents exempt from the regulations. Sources which have achieved emissions standards due to process changes were not considered in the study because the primary objective of the study was to evaluate control device operation and maintenance practices.

The 20 sources selected for study are only a small fraction of the more than 1000 major stationary sources located in the State. No attempt has been made to determine the representativeness of this sample with respect to other sources. Due to the criteria used in the selection of the sample it is suspected that the sources are somewhat larger and more sophisticated than most sources in the State. It is also probable that the quality of data is better in the sample than for other sources as a group. Care should therefore be exercised in extrapolation of the conclusions presented in this work to the total population of North Carolina air pollution sources.

2. ANALYSES OF STATIONARY SOURCE PERFORMANCE

The principal findings of the stationary source inspections and evaluations are presented in this section. The findings are analyzed with respect to three important subjects: (1) control equipment performance relative to compliance requirements, (2) potential benefits and economic impact of agency program modifications, and (3) effectiveness of source/agency interaction. Specific findings are also presented. The quality of data available and the extent of cooperation received from source representatives and agency personnel is reviewed to indicate the type of information which was obtained in the study.

2.1 SOURCE/AGENCY CONTROL AND DATA QUALITY

2.1.1 Source/Agency Cooperation

PEDCo Environmental was very pleased with the cooperation received from source representatives and from North Carolina Air Quality Section personnel. We have no reason to believe that any meaningful data was withheld in the majority of cases. In some instances, source personnel volunteered information not specifically requested.

2.1.1.1 General Policies Adopted to Encourage Cooperation

The high level of cooperation enjoyed in this project results from three factors:

1. Most source representatives are honestly committed to compliance with air pollution control regulations regardless of their opinions regarding the fairness of specific regulations;
2. The North Carolina agency had good working relationships with many of the sources at the time this study was conducted; and
3. PEDCo Environmental and Booz, Allen & Hamilton have adopted study procedures which respect the interests of the source operator.

Considerable effort was devoted to establishing study procedures and inspection protocol which was fair to all parties involved. PEDCo believed that such efforts were vital to the success of the study. It should be noted that the majority of the plants have been visited previously by EPA contractors and employees. In some cases, visits have occurred at a rate of 2-5 times per year. In many cases large contingencies (up to 12 people) visit the plant and detain key plant personnel 1-2 days. Despite promises made at the time of a visit, plant personnel rarely have an opportunity to review draft reports and rarely receive a final report on the project. Many of the source representatives confessed that they participate in these voluntary studies only because they have received management directives requiring them to be cooperative. PEDCo Environmental has tried to proceed in a responsible manner in hopes of offsetting this prejudice of source personnel to "yet another" study. Each source has had an opportunity to review the inspection report for the control device inspected at its plant. PEDCo Environmental believes the results of the inspections demonstrate the success of these policies.

2.1.1.2 Inspection Protocol

A general inspection protocol was prepared to ensure proper project management and equitable treatment of agency and source personnel.

The North Carolina regional office personnel contacted each source to be studied in their respective regions and arranged a date for the visit. Upon notification of the date PEDCo sent a letter of introduction to the source representative explaining the general objectives of the study and requesting that certain material be compiled so that we would not detain source personnel longer than necessary. In this letter PEDCo emphasized that cooperation was entirely voluntary and that confidential material would not be released. A sample introductory letter is presented in Appendix B.

Prior to the day of the inspection, a PEDCo representative visited the regional office and carefully examined files concerning the source of interest. Information was recorded on the Source Information Checklist (see Appendix B). We attempted to visit the regional offices on Mondays, at the request of persons at the August 29th meeting (see Section 1).

The North Carolina regional engineer accompanied PEDCo personnel to the plant to introduce source representatives, then left so that PEDCo and source representatives could discuss continuous compliance problems on a confidential basis. The source visits included, but were not limited to, an inspection of the control device(s) of interest, a review of emissions data, spare parts inventories, cost data, and an evaluation of preventive maintenance programs. We attempted to meet with the plant manager, chief engineer and maintenance foreman at various times during the source visit.

A draft report was then prepared for Booz, Allen & Hamilton's review. Each source inspector/evaluation report was sent to the source for review of accuracy and completeness. Copies of the final report will be sent to each company included in the study.

2.1.2 Data Quality

There was a serious lack of quantitative emissions data available for most of the 20 sources evaluated, even though these sources are "data rich" relative to most other plants in the State of North Carolina. As contract requirements for this study specify that emissions profiles be constructed, we have provided estimates for all sources visited. In many cases we feel that neither data contained in State agency files, records made available by the sources, nor emissions rates reported in the literature justified construction of emissions profiles of this type, We therefore recommend caution in the use of these profiles, and we recommend that in any future references to this data, appropriate discussions of data quality be included. The information sources used to construct individual emissions profiles are described in Section 5.3 of each source inspection report in Appendix A.

The availability of emissions data and control equipment performance records is summarized in Table 2-1. Continuous monitors are in use at only three of the 20 sources inspected. Each of these sources uses electrostatic precipitators. For fabric filters and carbon bed adsorbers there

Table 2-1. DATA AVAILABILITY.

Control Device		Source Number	Size (SCFM)	Age (Years)	Operating Records	Stack Tests	Continuous Monitors
Electrostatic Precipitators	Neg. Corona	1	4×10^6	4	Good	2	8
		6	5.4×10^5	2	Good	1	0
		8	5×10^5	2	Good	1	1
		5	5.5×10^5	4	Good	2 - 5	1
	Pos. Corona	13	1.1×10^4	3	None	0	0
Fabric Filters	Reverse Air	4	3.4×10^4	4	None	0	0
	Pulse Jet	11	3×10^4	2	None	0	0
	Shaker	14	2.4×10^4	25	None	0	0
		19	9.5×10^3	4	Good	0	0
		3	3.6×10^4	2	None	0	0
Carbon Bed Adsorbers		12	1×10^4	5	Good	0	0
		10	3×10^4	2	None	0	0
Scrubbers	Impingement	7	4.0×10^4	2	None	3	0
		15	2.5×10^4	3	None	1	0
	Venturi	16	3.3×10^4	2	None	1	0
		20	6.0×10^3	6	None	0	0
	Packed Bed	18	1.5×10^4	6	None	1	0
	Wet Cyclones	9	2.0×10^4	2	None	0	0
		2	9×10^3	6	None	0	0
Afterburner		17	5×10^3	1	None	0	0

are no stack test data because the agency assumes that a source is in compliance when these control techniques are used. For other types of control devices, stack tests are performed infrequently. Few sources have had more than one test during the operating life of the control devices. This is partly due to the newness of most of the control equipment and partly due to the agency's policy to test only when operating permit renewals are requested. In some cases, stack tests were probably performed under unrepresentative conditions, measuring the best possible efficiency rather than the typical performance level. Thus, there is little direct emissions data useful for this study.

The possibility of a lack of data was anticipated at the inception of the study. In order to achieve project goals it was proposed that indirect, "investigative engineering" based on operating records, be used to reconstruct an approximate emissions histories. As indicated in the center column of Table 2-1, the majority of sources do not maintain even the simplest records, thereby, complicating the investigative engineering approach considerably. It should also be noted that those sources maintaining adequate records discard them after several months since they are interested only in short-term trends.

In order to compensate for the lack of emissions data and operating records, PEDCo attempted to interview as many plant personnel as possible and performed internal equipment inspections when permitted by the sources. The internal condition of the equipment provided a physical record of operating practices at some sources.

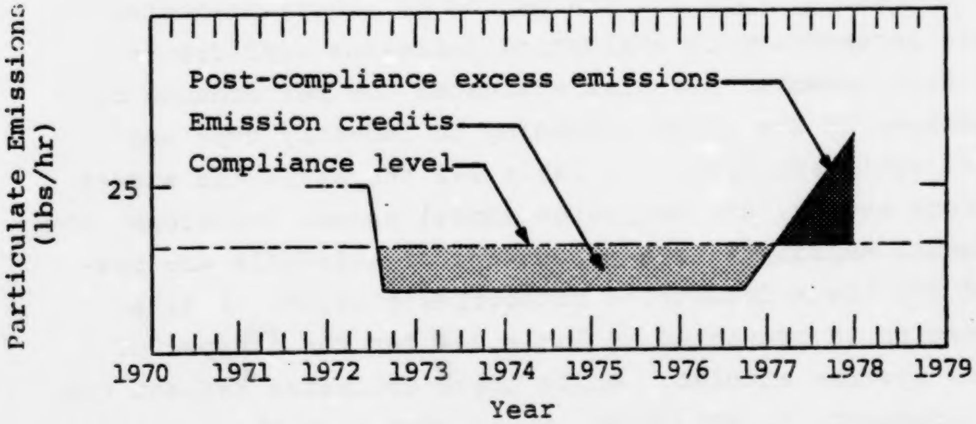
2.2 ANALYSIS OF STATIONARY SOURCE PERFORMANCE

The data compiled during source inspections and interviews with regional office staff has been assembled into a series of tables to facilitate analyses. The individual inspection results are analyzed here as a group so that general trends and findings can be determined. This section is subdivided into the analyses of control equipment performance, costs and benefits of potential changes in the agency's program, and source/agency interaction.

2.2.1 Summary of Control Equipment Performance Analyses

The performance of the control devices was evaluated based on available data and the results of our external and internal inspections. We attempted to determine the frequency and duration of excess emissions incidents and to infer the casual factors. These analyses were designed to formulate useful corrective actions.

Emissions data have been summarized into annual average emission profiles, included with each inspection report. An example profile (taken from Source 2 report) is shown for illustrative purposes in Figure 1-1. The quantity of excess emissions can be calculated by graphically integrating the area defined by difference in actual emissions and required control. Excess emissions are the total of the area above the regulatory limit during the entire period of the study summarized. The accuracy of these estimates range from (±25 to ±500%). The integrated total of "emission credits" are



also reported. This number indicates the quantity of pollutants which could have legally been emitted but were controlled. Certainly emissions credits do not excuse a source for excessive emissions since the latter could lead to violations of ambient air quality standards. Nevertheless, substantial emission credits reflect proper design, and good long-term operation/ maintenance practices. Emissions credits normally result if a control device is designed with a sufficient margin of safety to ensure continuous compliance given the variable nature of industrial processes. Additional emissions credits can result if a source designs its control devices with efficiencies beyond what is required for this margin of safety. No distinction is made in this report between these two sources of emissions credits. The emissions credit concept is included in the report because a decrease in emissions credits due to poor operation and maintenance of control equipment can impact on the total emissions inventory of a region, even though compliance status of the sources may remain the same.

The results of the emissions estimates for each source are compiled in Table 2-2. The values for potential uncontrolled emissions and allowable emissions (emission rate x total operating hours for the period of study) presented to provide perspective in evaluating emissions performance. PEDCo Environmental has also evaluated the performance of the sources in the study according to industry type and control equipment type. In Table 2-3 the estimated excess emissions events, the estimated annual excess emissions, and the annual emissions as a percentage of allowable are presented for the 8 industrial categories studied. Similar information is presented in Table 2-4 for the 5 types of control systems studied. While these estimates reflect our best judgement, it should be appreciated that these analyses are inherently speculative.

The majority of the excess emission problems identified in this study could have been effectively handled using the existing regulations and enforcement procedures of the

Table 2-2. CONTROL EQUIPMENT PERFORMANCE

Source Number	Control Equipment Type	Age	Accuracy of Estimates	Emissions (Annual Average X Age)		Emission Credits, T	Excess Emissions, T
				Uncontrolled Emissions, T	Allowable Emissions, T		
1	Electrostatic Precipitator	4	± 25%	1,000,000	16,000	1,000	3,375
2	Cyclonic Scrubber	5	± 200%	3,000	360	134	7.5
3	Shaker Type Fabric Filter	6	± 300%	10,000	200	160	1.5
4	Reverse Air Fabric Filter	4	± 500%	2,600	N/A	N/A	N/A
5	Electrostatic Precipitator	4.5	± 200%	128,000	640	400	222
6	Electrostatic Precipitator	2	± 50%	416,000	1,600	1,500	0
7	Impingement Type Scrubber	5	± 100%	3,000	56	0	150
8	Electrostatic Precipitator	2	± 300%	78,000	1,250	275	0
9	Cyclonic Scrubber	2.5	± 200%	12,400	960	2	10
10	Carbon Bed Adsorber	2	± 200%	2,800	420	120	0
11	Pulse Jet Fabric Filter	2	± 500%	12,600	816	17	4
12	Carbon Bed Adsorber	5	± 20%	10,000	1,500	400	170
13	Positive Corona Precipitators	3	± 200%	630	210	33	15
14	Shaker Type Fabric Filter	25[a]	N/D	N/D	N/D	N/D	N/D
15	Impingement Type Scrubber	4	± 200%	3,300	900	375	112
16	Venturi Scrubber	2	± 200%	54,000	100	25	0
17	Afterburner	1	N/D	N/D	N/D	N/D	N/D
18	Packed Bed Scrubber	5	± 300%	1,860	180	46	0
19	Shaker Type Fabric Filter	4	± 500%	2,600	N/D	32	0.3
20	Venturi Scrubber	6	± 300%	600	240	160	0

N/A Data Not Available

(a) actual age is not known

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Table 2-3. EXCESS EMISSIONS FOR CATEGORIES OF SOURCES STUDIED IN NORTH CAROLINA

Source Category	Combined Years of Emissions Studied	Estimated Number and Duration of Excess Emissions Events[1]				Estimated Excess Emissions[2] (T/yr)	Estimated Average Annual Emissions[2] (% allowable)	Emissions Indicators (see notes)
		>12 mo.	1-12 mo.	1 da.-1 mo.	<1 da.			
1. Steam Generating Plants (3)	12½	2	3	2	unknown	3,700	175	3,6,7,4
2. Pulp & Paper Mills (3)	6	0	0	0	unknown	0	38	5,6,7
5. Asphalt Plants (1)	2	0	0	0	35	4	100	7
8. Iron & Steel Plants (1)	5	1	0	0	0	150	1440	6,7
11. Petrochemical Plants (1)	4	0	0	0	100	0.5	10	7
12. Stone, Clay & Glass Plants (4)	12½	1	1	0	unknown	17	105	6,7
14. Fertilizer Plants (2)	12	0	1	0	140	1.5	35	7
15. Lumber and Wood Products (1)	4	0	0	0	120	not applicable	not applicable	7
16. Surface Coating Operations (4)	11	1	0	2	2	185	116	5,7

1. The number of minor excursions above allowable emissions rates (i.e., 1 hour or less) cannot be estimated in most cases. For fabric filters it is arbitrarily assumed that 2 bags fail per month, resulting in excursions of more than 1 hr. but less than 1 day.
2. All sources emit particulates except for 2 of the surface coating operations which emit hydrocarbons.
3. Opacity records.
4. Malfunction reports.
5. Operating logs.
6. Stack tests.
7. Engineering judgment.

Table 2-4. EXCESS EMISSIONS FOR CATEGORIES OF CONTROL DEVICES STUDIED IN NORTH CAROLINA

Control Device Type	Combined Years of Emissions Studied	Estimated Number and Duration of Excess Emissions Events				Estimated Excess Emissions[2] (T/yr)	Estimated Average Annual Emissions[2] (% allowable)	Emissions Indicators (see notes)
		>12 mo.	1-12 mo.	1 da.-1 mo.	<1 da.[1]			
1. Electrostatic Precipitators (5 devices)	15	1	3	2	N/D	3610	157	3,5,6,7,4
2. Fabric Filters (5 devices)	16	0	1	0	397	6	82	7
3. Carbon Bed Absorbers (2 devices)	7	1	0	2	2	170	117	5,7
4. Scrubbers (7 devices)	29.5	3	1	0	N/D	280	120	6,7
5. Afterburner (1 device)	1	N/D	N/D	N/D	N/D	N/D	N/D	N/D

1. The number of minor excursions above allowable emissions rates (i.e., 1 hour or less) cannot be estimated in most cases. For fabric filters it is arbitrarily assumed that 2 bags fail per month, resulting in excursions of more than 1 hr. but less than 1 day.
2. All sources emit particulates except for the 2 carbon bed absorbers operations which emit hydrocarbons.
3. Opacity records.
4. Malfunction reports.
5. Operating logs.
6. Stack tests.
7. Engineering judgment.

(a) One unit not included in totals due to lack of data.

State. The present enforcement procedures are sometimes exercised in a superficial manner, and are therefore considerably less effective than necessary. Table 2-5a lists the primary and contributing causes of excess emissions at the sources studied. Table 2-5b lists the possible corrective strategies that could have been employed by the State agency to prevent these excess emissions.

There are several major conclusions which can be reached based on the data presented in Table 2-2. The quantities of excess emissions calculated is significant with respect to the uncontrolled emissions values. It is apparent that performance in the "post-compliance" period may be less effective than originally assumed, in many cases. Equally surprising is the magnitude of the emissions credits. In some cases, the credits are considerably larger than the corresponding excess emissions, demonstrating that the long-term performance of the equipment in these cases has been good. Due to the high collection efficiency characteristics of fabric filters, these systems generally result in substantial emission credits. Electrostatic precipitators at the kraft pulp mills also resulted in greater credits values than excess emissions values.

2.2.2 Summay of Cost Analyses

One of the principal purposes of this study and the related studies being conducted in other states is to evaluate the need for and the cost effectiveness of possible economic incentives. According to Section 405 of the Clean Air Act Admendments of 1977, these incentives could be built into the existing regulatory framework or could take the form of additional regulations. Since the latter has not yet been proposed even at the conceptual level, we have limited these economic analyses to possible changes in the existing North Carolina program which could be accomplished without regulatory changes.

Based on the results of the source inspections and the numerous interviews with headquarters and regional personnel, we have listed several changes which could conceivably

Table 2-5a. CAUSES OF POST-COMPLIANCE (OR POST-PERMIT APPROVAL) EXCESS EMISSIONS AT SOURCES INCLUDED IN THE STUDY

Causes of Excess Emissions	Number of Sources Where this was the Primary Cause of Excess Emissions	Number of Sources Where this was a Contributing Cause of Excess Emissions
Poor Design Efficiency	5	2
Corrosion/Improper Materials of Construction	3	6
Improper Control Equipment Installation Practices	0	1
Lack of Instrumentation	0	2
Lack of Spare Parts	0	1
Routine (not preventable) Component Failure	4	1
Improper Operation of Equipment	0	1
Improper Maintenance of Equipment	1	2

Table 2-5b. CORRECTIVE STRATEGIES AVAILABLE TO THE STATE AGENCY TO REDUCE EXCESS EMISSIONS AT SOURCES INCLUDED IN THE STUDY

Strategy Description	Number of Sources Where This Would Have Been the Most Successful Strategy	Number of Sources Where This May Have Been Somewhat Helpful in Reducing Emissions Violations
Improve Permit Review for New Sources	8	3
Retrofit of Additional Instrumentation	1	6
Require More Complete Spare Parts Inventory	0	2
Increase Technical and Economic Support of Field Inspectors	3	5
Increase Record Keeping Requirements	1	6
Increase Maintenance Requirements	1	5
Require Annual Stack Tests	0	3

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improve the effectiveness of the program. The possible impact on the costs incurred by the sources and the benefits with respect to reduced excess emissions quantities are estimated. Although these analyses may be inaccurate when applied to one specific source, we believe that the results are meaningful and more accurate for the group taken as a whole.

Results of the source evaluations indicated that numerous design deficiencies contributed to excess emissions. A more comprehensive new source permit review program could conceivably identify some of these problems at the stage where appropriate corrections could be easily made. The improved permit review would have a direct impact on the capital cost of the control equipment. The costs and benefits of a more comprehensive permit review are presented in Table 2-6.

Most of the existing operating permits include stipulations that recordkeeping and/or specific maintenance plans can be required at the discretion of the regional agency. Presumably, it would require some labor time on the part of the source operators to implement these requirements, if envoked. These costs are presented in Table 2-7 along with the estimated excess emission reduction benefits at these sources.

Increased technical and economic support of the field inspector is also analyzed in Table 2-7. This could include issuing inspectors detection equipment (fluorescent dye tracer kits, strobes, inductive ammeters, etc.), providing them up-to-date technical literature, providing access to computer facilities, and encouraging regional engineers to meet on a regular basis to discuss common problems. It is believed that increased support of field personnel is a particularly important program change which would cost relatively little for the State and which would have a major impact on the performance of the sources.

Table 2-6. POTENTIAL BENEFITS AND CAPITAL COST IMPACT OF REGULATORY PROGRAM CHANGES

Control Equipment			Improved Permit Review For "New" Sources		Retrofit of Additional Instrumentation		Require More Complete Spare Parts Inventory	
Source Number	Type	Total Installed Costs ($1000)[a]	Costs ($1000)[c]	Potential Reductions in Excess Emissions(%)	Costs ($1000)[c]	Potential Reductions in Excess Emissions(%)	Costs ($1000)[c]	Potential Reductions in Excess Emissions(%)
1	Electrostatic Precipitator	20,000	> 6,000	99	0	0	0	0
2	Cyclonic Scrubber	35	(20)	95 - 99	8	25 - 95	8	0
3	Shaker Type Fabric Filter	Unknown	Unknown	95 - 99	Unknown	5 - 10	0	0
4	Reverse Air Fabric Filter	485	150	50	< 25	5 - 10	0	0
5	Electrostatic Precipitator	4,600	> 2,000	95	0	0	0	0
6	Electrostatic Precipitator	22,000	0	0	< 200	0	0	0
7	Impingement Type Scrubber	300	30	75 - 95	20	0 - 5	0	0
8	Electrostatic Precipitator	10,000	0	0	0	0	0	0
9	Cyclonic Scrubber	5	1	99	0.5	5 - 10	0.5	5 - 10
10	Carbon Bed Adsorber	600	0	0	0	0	0	0
11	Pulse Jet Fabric Filter	91	0	0	0	0	0	0
12	Carbon Bed Adsorber	850	250	25 - 50	0	0	0	0
13	Positive Corona Precipitator	700	0	0	< 70	5 - 10	0	0
14	Shaker Type Fabric Filter	30[b]	150	99	1	50	1	25 - 50
15	Impingement Type Scrubber	70	(35)	95 - 99	< 1	50	0	0
16	Venturi Scrubber	200	0	0	0	0	0	0
17	Afterburner	Unknown	Legal status unclear		Legal status unclear		Legal status unclear	
18	Packed Bed Adsorber	Unknown	0	0	Unknown	0	0	0
19	Shaker Type Fabric Filter	Unknown	0	0	0	0	0	0
20	Venturi Scrubber	Unknown	0	0	Unknown	0	0	0

[a] 1978 dollars unless otherwise noted.

[b] 1953 dollars.

[c] Parentheses denote negative costs or "savings."

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Table 2-7. POTENTIAL BENEFITS AND OPERATING COST IMPACT OF REGULATORY PROGRAM CHANGES

Control Equipment		Increased Technical/ Economic & Administrative Support of Inspectors			Increased Recordkeeping Requirements		Increased Operation & Maintenance Plan Requirements		Annual Stack Testing Requirements	
Source Number	Type	Operating Costs[a] ($/Yr.)	Annual Costs[a] ($/Yr.)	Potential Reductions in Excess Emissions(%)	Annual Costs[a] ($/yr.)	Potential Reductions in Excess Emissions(%)	Annual Costs[a] ($/Yr.)	Reductions in Excess Emissions(%)	Annual Costs[a] ($/Yr.)	Reductions in Excess Emissions(%)
1	Electrostatic Precipitator	475,000	20,000	0	0	0	0	0	25,000	0
2	Cyclonic Scrubber	Unknown	5,000	95 - 100	5,000	95 - 100	5,000	95 - 100	15,000	0
3	Shaker Type Fabric Filter	Unknown	1,000	5 - 10	1,000	5 - 10	2,000	0	15,000	0
4	Reverse Air Fabric Filter	Unknown	2,500	75 - 90	5,000	5 - 10	2,000	75 - 90	Cannot be tested	
5	Electrostatic Precipitator	Unknown	10,000	50 - 75	10,000	5 - 15	10,000	0	20,000	50 - 75
6	Electrostatic Precipitator	Unknown	0	0	0	0	0	0	15,000	0
7	Impingement Type Scrubber	15,000	1,500	5 - 10	3,000	10 - 25	1,500	5 - 10	20,000	10 - 25
8	Electrostatic Precipitator	>30,000	0	0	0	0	0	0	15,000	0
9	Cyclonic Scrubber	Unknown	1,000	10 - 25	2,000	10 - 25	2,000	10 - 25	15,000	25 - 50
10	Carbon Bed Adsorber	Unknown	0	0	5,000	0	5,000	0	Cannot be tested	
11	Pulse Jet Fabric Filter	6,000	1,500	10 - 25	1,000	0	2,000	0	15,000	0
12	Carbon Bed Adsorber	Unknown	20,000	25 - 50	5,000	0	5,000	0	Cannot be tested	
13	Positive Corona Precipitator	>15,000	1,500	0	3,000	0	3,000	0	Cannot be tested	
14	Shaker Type Fabric Filter	Unknown	5,000	50 - 75	3,000	5 - 25	3,000	50 - 90	Cannot be tested	
15	Impingement Type Scrubber	12,000	1,200	0	1,200	0	1,200	0	20,000	0
16	Venturi Scrubber	120,000	6,000	0	0	0	0	0	15,000	0
17	After burner	Unknown	Legal status unclear		Legal status unclear		Legal status unclear		Legal status unclear	
18	Packed Bed Scrubber	Unknown	0	0	2,000	0	2,000	0	15,000	0
19	Shaker Type Fabric Filter	5,500	0	0	0	0	0	0	Cannot be tested	
20	Venturi Scrubber	Unknown	1,000	0	2,000	0	2,000	0	15,000	0

[a] 1978 dollars.

Other possible program changes could include requirements for stack tests on a regular basis and requirements for extensive spare parts inventories. The costs and benefits of these are analyzed and presented in Table 2-6. These changes would be relatively costly to the sources and might have minor impact. None of the cases analyzed has suffered from the poor availability of spare parts and none of the estimated excess emissions could be assigned to this problem. The costs for the stack tests are extremely high and in some cases the results are not very useful. In many cases, stack tests merely document the best possible emissions control achievable under ideal process and control device conditions, while in other cases, the emissions are too variable to be adequately characterized by a single yearly emission test.

2.2.3 Summary of Source/Agency Interaction

The state of North Carolina has adopted a policy of voluntary cooperation in the regulation of industrial air pollution sources. The intent of this approach is partially to encourage effective control without the time consuming and sometimes ineffective legal action. The voluntary cooperation system is well suited to the State since most sources are conscientious and basically committed to compliance.

While the voluntary cooperation policy is appropriate for North Carolina there are weaknesses in the present implementation of the policy. Specifically, the agency provides very little technical and economic support for the field inspector. This is a problem because in a voluntary cooperation approach the field inspector is particularly influential. The inspector must be an effective "salesman" for the program and must be sufficiently competent to identify any attempt by source to slip-by with less than effective operation and maintenance procedures. In other words, the inspector must be able to foster an attitude of mutual respect with the operators of the source. In order to accomplish this goal the inspector must have an understanding of the operating characteristics of the control equipment and he must have equipment to conduct both external and internal inspections. Unfortunately, few of the inspectors presently have access to such equipment.

Table 2-8 includes an assessment of some of the qualitative aspects of source/agency interaction. In the first column, the effectiveness of the voluntary cooperation policy is rated. Principal items considered necessary to have an "effective" relationship includes (1) mutual respect, (2) open exchanges of information, and (3) flexibility. As noted in Table 2-8, the results of 12 source evaluations indicate effective source/agency interaction. This is remarkable considering the limitations imposed on the field inspectors. For 3 of the cases, a lower rating has been assigned since some problems have been identified. These marginal cases involve failures to report excess emission incidents and/or initial source recalcitrance in installing necessary control equipment. The remaining five cases exhibit one or more potential problems in the source/agency relationship. Due to the diversity of these problems, no attempt has been made to assign qualitative ratings.

The developing of a relationship of mutual respect is partially dependent on the quality of routine inspections done by the field inspector. It is important to demonstrate technical awareness of the system operating characteristics as well as the ability to identify potential problems. The quality of inspections has been rated in the second column. Superficial inspections means that the inspector relies only on opacity to determine compliance, fails to review available records, and/or fails to perform internal inspections when possible. A sufficient inspection means that the inspector has exerted the necessary effort to accurately determine compliance but has not attempted to identify developing problems.

Table 2-8. ASPECTS OF SOURCE/AGENCY INTERACTION.

Source Number	Effectiveness of Voluntary Cooperation Policy	Quality of Plant Inspections	Inspector Aware of Excess Emissions	Source Adherence to Malfunction Reporting Requirements
1	Effective	Comprehensive	Yes	Yes
2	Marginal	Superficial	No	No
3	Effective	Sufficient	N/A	N/A
4	(Not rated)	Superficial	N/A	N/A
5	Marginal	Superficial	No	Yes
6	Effective	Superficial	N/A	No
7	Marginal	Superficial	Yes	N/A
8	Effective	Comprehensive	N/A	Yes
9	(Not rated)	Sufficient	Yes	No
10	Effective	Sufficient	N/A	Yes
11	Effective	Comprehensive	Yes	Yes
12	(Not rated)	Superficial	No	Yes
13	Effective	Comprehensive	Yes	Yes
14	(Not rated)	Superficial	Yes	No
15	Effective	Sufficient	Yes	Yes
16	Effective	Superficial	N/A	No
17	(Not rated)	Superficial	N/A	N/A
18	Effective	Sufficient	N/A	N/A
19	Effective	Comprehensive	Yes	Yes
20	Effective	Sufficient	Yes	Yes

N/A - Not applicable.

In several of the source evaluations, excess emissions problems were identified which were apparently unknown to the field inspector. This indicates a serious breakdown in the effectiveness of the inspector and makes any other rating of the source/agency interaction meaningless. These instances are listed in column 4 of Table 2-8.

Some of the operating permits include a stipulation that malfunctions be reported within 12 hours of the occurrence. Failure to report these problems indicates a lack of respect of the inspector. This problem was noted in only a few of the cases.

2.3 GENERAL FINDINGS

Four general findings are presented in this section. Each of these general findings is based on several of the specific finding discussed in Section 2.4 of this report. The overall conclusion reached in the stationary source evaluations is that the vast majority have made a good faith effort to comply and that the voluntary cooperation approach adopted by the State is effective despite several implementation problems in the new source permit review and the existing source inspections activities.

General Finding #1 - Compliance determination capability is limited.

In a large number of the cases evaluated, neither the source nor the agency has the detection capability to determine if the control device is operating properly and within compliance requirements. This is due, in part, to a lack of adequate control equipment instrumentation. In addition, the agency contributes to this problem by not performing or requesting stack tests for selected sources at a frequency necessary to verify compliance.

General Finding #2 - The permit review program is too weak.

Permits have been approved for control devices which are substantially undersized, devices with inadequate or nonexistent instrumentation, and devices with limited or nonexistent access capability for maintenance. In other cases, improper materials of construction have been approved for control devices that are to provide service under corrosive conditions. The ultimate consequence of these superficial procedures has been failure of many units and excess emissions. In these cases, the source has become a "problem" requiring considerable agency attention. The economic impact on the sources for repair or replacement of the equipment is severe. While the agency should stop short of specifying control techniques and/or design parameters, it should advise the source of probable design errors and, in such cases, issue a conditional permit requiring frequent stack tests and inspections.

General Finding #3 - The routine inspections conducted on a quarterly basis are too superficial.

During some inspections, the field inspectors merely record opacity and they fail to examine the equipment, the instrumentation, or the available records. During other source visits, "walk around" inspections are performed, but no serious effort is made to identify developing or existing compliance problems. This problem is often due to the lack of time available for each inspection, and to the lack of test instruments necessary to properly inspect control equipment.

General Finding #4 - The voluntary cooperation policy of the State appears to be surprisingly effective.

In a large number of cases, the field inspector has been able to develop a relationship of mutual respect with source operators. Control equipment problems have been handled effectively with a minimum of red tape. It is concluded that the policy is well suited to the conditions in the state of North Carolina. The problems identified as General Findings 1-3 concern the manner in which policy is implemented and do not imply shortcomings in the basic design of the regulatory approach.

2.4 SPECIFIC FINDINGS

A number of specific findings were reached based on the inspection and evaluation of the sources. These findings are discussed in some detail and examples illustrating these findings are presented. Details concerning each of the examples are provided in the individual source reports of Appendix A.

Specific Finding #1 - There is inadequate control equipment instrumentation to determine compliance.

Certain control equipment monitoring instruments are generally required in order to routinely evaluate the operating characteristics of the control device and the effluent handling systems as a whole. Fan static pressure, gas temperature and current should be measured at all installations. Differential pressure gauges should be installed across all fabric filter and wet scrubber systems. Other parameters which should be measured in selected cases include liquor pH, liquid flow rates (wet scrubbers), and air pressure (pulse jet fabric filters). A number of the wet scrubbers and fabric filters evaluated did not include these fairly simple instruments despite the low cost relative to the total cost of the system. In most cases, there have been significant excess emission incidents.

Examples -Case Number 7. An impingement type wet scrubber is used to control particulate emissions from a cupola. Severe corrosion occurred due partly to the lack of pH monitors.

Case Number 9. There are no instruments whatsoever on this set of cyclonic wet scrubbers. It is impossible to verify that there is proper water flow to the unit. Opacity readings are very difficult due to steam plumes.

-Case Number 14. No differential manometers are installed on this old shaker type fabric filter. It is impossible to identify possible fabric tears, blinding, or other failures of the cleaning system.

-Case Number 18. No instruments of any kind are included on this packed bed scrubber serving a rotary drier. Opacity readings can be very misleading.

-Case Number 20. Liquid flow rate, pH, and throat pressure drop are important para meters with respect to the proper operation of this scrubber. No instrumentation of any kind is included in the effluent hand-ling system or the control equipment.

Specific Finding #2 - The new source permit review procedures should attempt to identify improper materials of construction.

Some of the smaller industrial sources evaluated in Task II had constructed "homemade" wet scrubbers or had purchased units from small, inexperienced vendors. Due to corrosive contaminants in the effluent gas stream, these wet scrubbers rapidly deterioated to the point of complete failure. The consequences include expensive repair and/or replacement and extended periods of excess emissions while the units were being repaired. While it is not the function of the agency to aid in the design of the control equipment, the failures which occurred to these sources are typical of numerous cases throughout the country which are described in detail in the technical literature. The agency should have warned the sources of the possible problems, thereby saving considerable money on the part of the source and reducing excess emissions.

Examples -Source Number 2. The company operates a carbon steel cyclonic wet scrubber which has HF contaminants in the liquor. The unit suffered from moderate corro-sion problems until the N. C. Water Quality Section required liquor recirculation. This contributed to a rapid scrubber failure. A similar replacement unit suffered a second corrosion failure in less than 6 months.

-Source Number 9. The cyclonic wet scrubber handle a potentially corrosive effluent from a rotary drier. No corrosion is obvious at the present time, however, it is anticipated that this could be a problem in the future.

-Source Number 7. The foundry operates an impingement scrubber of very unusual design Carbon steel was used despite the presence of highly corrosive SO_2 in the cupola effluent. Serious compliance problems have occurred for over 5 years.

-Source Number 15. A unit identical to that of source 7 was installed on a coal-fired industrial boiler. Complete failure occurred in less than 2 months. The unit operated at a low efficiency for a period of 2 years while the scrubber components were replaced at considerable cost.

Specific Finding #3 - Permit review procedures should be upgraded to identify under sizing of control equipment.

The undersizing of control equipment can effectively preclude compliance and/or result in subsequent maintenance problems. While the agency should not specifiy design parameters, it should notify source owners of the possible problems. Close surveillance of such installations should be maintained.

Examples -Source Number 1. An electrostatic precipitator is used to control particulate emissions from a new coal-fired boiler. The collection plate area is approximately 35% to 50% lower than normally considered necessary for low sulfur coal. The ESP ultimately required retrofit of a SO3 conditioning system in order to achieve marginal compliance.

-Source Number 4. A reverse air fabric filter is used to control stickly particulate emissions from an abrasive planer. The air-to-cloth ratio is much higher than normal for this type of filter.

Source Number 5. An electrostatic pre-cipitator was installed on a 30 year old utility boiler used for peaking service. The unit has a collection plate area ap-proximately 50% lower than necessary. The unit operates out of compliance 50% of the time.

Specific Finding #4 - The agency inspectors need more equipment to improve the scope of the inspection.

A number of inspectors interviewed during the course of the project did not appear to utilize adequate inspection techniques. In two cases, the inspector relied entirely on the opacity to indicate compliance problems. This is an extremely poor indicator of compliance as indicated by these two cases, one of which had high opacity but was in compliance with mass-emissions regulations, while the other had substantial violations but was within the opacity limits. This type of superficial inspection also conveys the impression to the operators that the inspector is not very knowledgeable or interested.

In a number of cases, it is apparent that the inspectors conduct relatively brief walk-through inspections. To a certain extent this is unavoidable due to the lack of time and a lack of useful its inspectors with detection equipment. The agency should provide the necessary detection equipment to perform a comprehensive inspection of air pollution control equipment. A partial list of the recommended equipment is provided below:

Materials Useful for Source Inspections

Hard Hat
Safety Shoes
Safety Glasses
Flourescent Tracer Kit
Respirator with Cartridges
Multimeter

Materials Useful for Source Inspections (continued)

- Gloves
- Tape Measure
- Flashlight
- Ear Protection
- Inductance Ammeter
- Manometers
- Stop Watch
- pH Paper
- Bucket
- Velometer
- Strobe Light
- Pump and Filter System
- Sample Bottles
- Fyrite Combustion Gas Analyzer
- Thermometers

All of this equipment does not have to be issued to each inspector. However, it would be useful to have all of the above items at each regional office to be available to any member of the staff. The cost of such equipment is trivial compared to the numerous administrative studies (such as this one) that analyzes the effectiveness of the programs.

In addition to providing inspectors with inspection instruments, we believe that the agency should have its inspectors perform internal inspections of control equipment, where possible. Internal inspections are useful in identifying the reasons for poor efficiency and they are often useful in identifying developing problems which could lead to future noncompliance.

The agency should adopt standard inspection techniques to improve the effectiveness of the time spent on-site at the sources. One possible approach is the Counterflow Technique and associated diagnostic procedure recently developed by J. Richards of PEDCo, for the Division of Stationary Source Enforcement (Contract #68-01-4147).

The use of proper inspection inspection instruments and the inspection procedures discussed above would lead to a more rapid determination of developing compliance problems and would probably reduce the excess emissions. Some examples in which proper use of inspection instruments would have been of benefit are listed below.

Examples -Source Number 2. The routine measurement of the scrubber pH would have provided an early indication of the impending corrosion problem.

-Source Number 4. Application of the Counterflow Inspection Technique and the use of the fluorescent tracers would aid in the identification of frequent operat-ing problems.

-Source Number 7. The routine measurement of the scrubber liquor pH would have pro-vided an early indication of the corrosion problems.

-Source Number 11. The use of fluore-scent tracers would aid in the location of bag tears which develop frequently due to damage to the unit during installation.

-Source Number 14. Use of the manometers and fluorescent tracers would be useful in verifying the compliance status of this unit.

Specific Finding #5 - The voluntary cooperation policy of the State can work surprisingly well.

Despite deficiencies discussed in this report, it appears that the basic approach used by the State can achieve the desired goals with a minimum red tape. Since most inspectors have an opportunity to work in the same geographical region for extended periods of time, they become very knowledgeable with respect to source characteristics and operator's attitudes. The cases demonstrating the effectiveness of the voluntary cooperation policies are listed below. This does not imply that the voluntary cooperation policy is a complete failure in the remaining cases, instead it means that a deficiency in the routine inspection or the permit review activities was suspected.

Examples -Source Numbers 1,3,4,6,8,11,15,16,18,19,20. In all of the above cases, the sources normally operate in compliance. Malfunctions are repaired quickly with a minimum of legal manuvering.

Specific Finding #6 - Since each facilility is unique, uniform regulations may be undesirable.

A number of specific site factors were noted during the course of the study that indicate the application of across the board regulations may be counterproductive. We suggest that the permit system be used instead so that the regulation of each source can be tailored to the specific problems.

Examples -Source Number 1. Due to the large size of this power plant, stack testing is extremely time consuming and expensive. Arbitrary stack testing requirements would involve considerable cost and would not provide significantly more data than is already available from the continuous opacity monitors.

-Source Number 4. There are a very large number of air pollution control devices in this plant complex. Extensive recordkeeping requirements would probably require more manhours than presently required to maintain the units and would not signifi-cantly reduce emissions.

-Source Number 8. The company maintains a computerized listing of spare parts. Only those items which are not locally available and have historically been necessary are kept on hand. A regulation requiring a standard inventory of spare parts would be moderately expensive but would probably not contribute to emissions reductions. Performance of the source is already excellent.

Specific Finding #7 - Some sources have designed control equipment to operate well below the emission limitations.

In a number of the cases evaluated the sources have installed control systems which perform considerably better than necessary to comply with mass-emissions limitations. This is almost always the case with fabric filters since the normal particulate control efficiency is in the range of 99.8% to 99.9%. Both kraft mills inspected have installed electrostatic precipitators on the recovery boilers which also operate at low emission levels. We believe that this demonstrates a good faith effort in equipment design and in operation/maintenance practices. The sources should receive some credit for this performance. We have "invented" a term called emission credits so that this factor can be presented in the individual source reports of Appendix A. It is particularly appropriate to include this number, since one of the objectives of the Section 405 studies is to determine incentives to encourage operation below emission regulations.

Examples -Source Numbers 6,8,15,18,19. In all of these cases the source routinely operate well below mass-emission limtations.

Specific Finding #8 - There need to be greater exchanging of information between regional engineers and source operators.

There is very little contact between the regional engineers despite the fact that there are similar control problems. In some cases, a source has repeated a serious mistake which had occurred in a plant located in a different administrative region. Regular meetings of regional engineers may have alerted the inspector involved so that the source operating practices could have been corrected. In another set of cases, two utilities installed electrostatic precipitators with almost identical specific collection plate areas (SCAs) to control particulate on boilers burning low sulfur coal. In one case, the inspector almost immediately recognized the compliance problem, while in the second case, the inspector was apparently unaware of most of the excess emission incidents. Based on the documented experiences of the first unit. the performance of the other plant should be seriously questioned.

In a few cases, the water quality inspectors have operated independently of the air quality inspectors causing some delay in the selection of equipment or contributing to corrosion problems in the control equipment.

Examples -Source Numbers 1 and 5. As discussed above, two very similar ESPs were installed to control boilers burning low sulfur coal. The similarities between the operating problems of the two units had not been recognized.

- Source Numbers 2 and 18. Two wet scrubbers are used to control very similar rotary driers. Due to water quality requirements, recirculation of liquor was started, leading to corrosion problems at one of the sources. The other source has aleviated corrosion using pH control.

- Source Numbers 7 and 15. Source 15 installed an unusual wet scrubber for control of boiler emissions; the unit corroded severely in 2 months. Source 7 subsequently installed a similar unit made by the same vendor; it suffered a similar fate.

APPENDIX A

SOURCE DESCRIPTIONS

SOURCE 1
ELECTROSTATIC PRECIPITATOR
SERVING PULVERIZED COAL-FIRED BOILER

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Pulverized Coal-Fired Boiler
Number of Employees	167
Number of Management Employees	5
Age of Equipment	4 years
Location	Rural

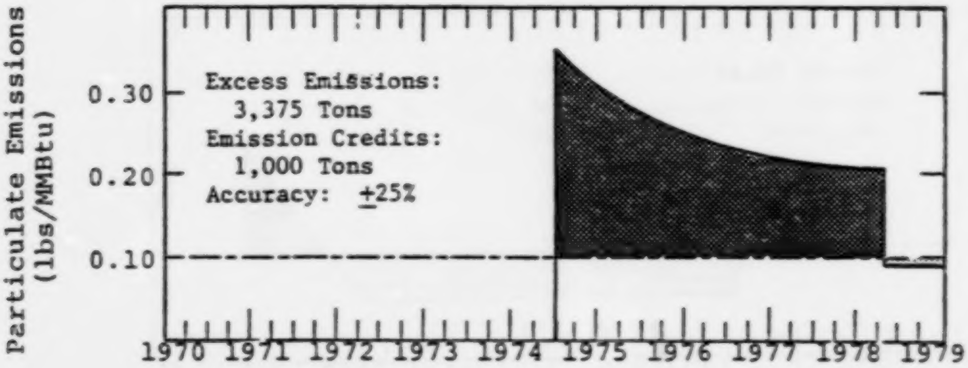
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	32 tons/hr
(from one unit)	115,200 tons/yr
Applicable Regulation	0.10 lb/10^6 Btu

C. Control Device Characteristics

Type of Control Device	Electrostatic Precipitator
Capacity of Control Device	400,000 ACFM @ 300°F
Age of Control Equipment	4 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

A large cold-side electrostatic precipitator serving a coal-fired utility boiler was inspected. Since start-up four years ago, an extensive series of modifications have been made in order to achieve compliance with particulate mass emission regulations and visible emission limitations. The precipitator has recently achieved compliance after installation of a flyash conditioning system. The records viewed demonstrate the source has taken all reasonable efforts to design and subsequently modify the precipitator to obtain the necessary collection efficiency.

SOURCE 2
WET CYCLONIC SEPARATORS SERVING TWO ROTARY DRIERS

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Oil-fired rotary dryers
Number of Employees	Less than 100
Number of Management Employees	Less than 10
Age of Plant	25 years
Working Schedules	160 hrs/wk 50 wks/yr
Location	Residential/rural

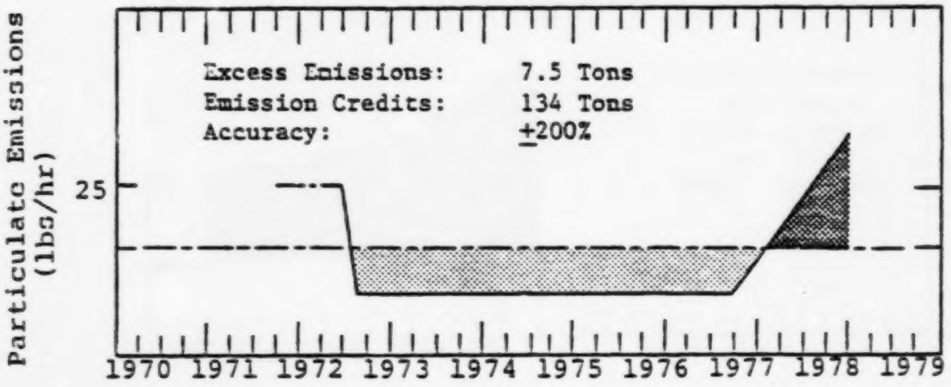
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	250 lbs/hr 500 tons/yr
Regulatory Requirement	16 lbs/hr

C. Control Device Characteristics

Type of Control Device	Wet cyclonic separator
Capacity of Control Device	9000 ACFM
Age of Control Equipment	(Replacement) 6 months

II. ANNUAL EMISSION PROFILE



III. SOURCE/AGENCY PERFORMANCE

The system is in an advanced state of decay due to severe corrosion of mild steel shell. Rapid deterioation began 12 months ago when the Agency demanded recirculation of liquor due to water quality considerations. Neither the source nor the Agency were cognizant of the consequences of this change. By means of an adequate preventive maintenance program and/or an aggressive inspection on the part of the Agency, this problem may have been recognized before severe excess emissions occurred. Costly repair and possibly complete replacement may be necessary to re-establish compliance.

SOURCE 3
FABRIC FILTER SERVING FERTILIZER PLANT ROTARY DRYER

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Fertilizer Plant
Number of Employees	Less than 60 (seasonal)
Number of Management Employees	5
Age of Plant	Unknown
Operating Schedule	130 hrs/wk, 15-20 wks/yr

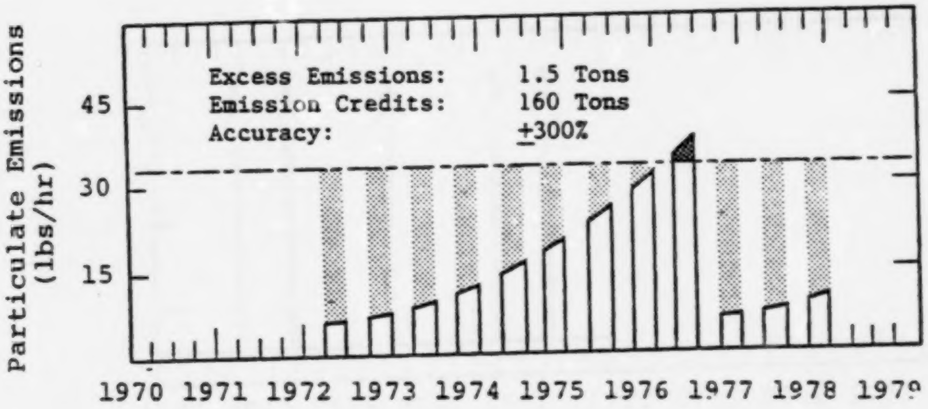
B. Pollutant Characteristics

Type of Pollutant	Particulates
Uncontrolled Emissions	4,000 lbs/hr
Applicable Regulation	31 lbs/hr

C. Control Device Characteristics

Type of Control Device	Multi-chamber fabric filter
Capacity of Control Device	36,000 Acfm @ 180°F
Age of Control Equipment	6 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The Source maintains the control system in good working condition. The Source conducts a responsible maintenance program to keep the fabric filters operating properly. The Source has a good working relationship with the State Agency and is cooperative during routine inspections and complaint investigations. The Agency is somewhat lax in requiring records from the Source for verification of continuous compliance. Emissions violations of less than 2 hr in duration may occur as often as several times a month because of equipment malfunctions (i.e., broken bags).

SOURCE 4
FABRIC FILTER
SERVING ABRASIVE PLANAR

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Furniture Plant
Number of Employees	More than 500
Number of Management Employees	Unknown
Age of Plant	Unknown
Operating Schedule	120 hrs/wk, 50 wks/yr
Location	Commercial/Residential

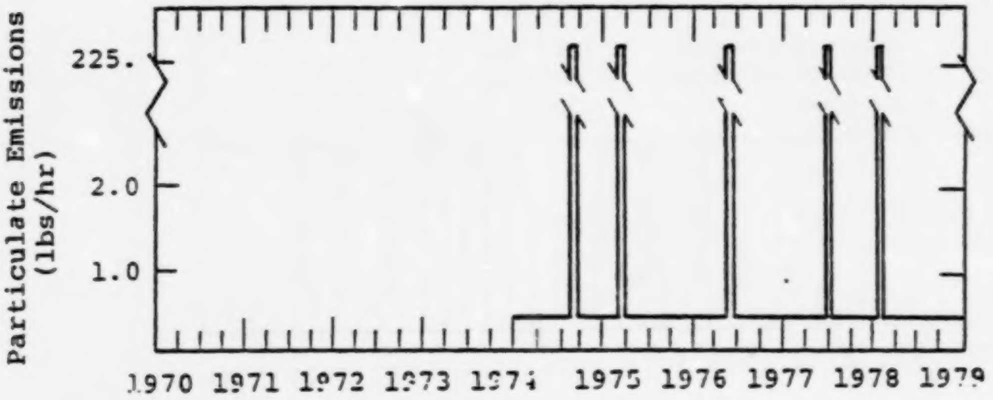
B. Pollutant Characteristics

Type of Pollutant	Particulates
Uncontrolled Emissions	650 tons/yr
Applicable Regulation	Good Equipment Design

C. Control Device Characteristics

Type of Control Device	Reverse Air Fabric Filter
Capacity of Control Device	33,600 ACFM @ 70°F
Age of Control Equipment	4 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The Source maintains the control system in good working condition. Emissions violations of less than 1 hr in duration probably occur several times a year because of equipment malfunction (i.e., broken bags). The Source conducts a responsible maintenance program to keep the fabric filters operating properly. The Source has a good working relationship with the State Agency and is cooperative during routine inspections and complaint investigations. The Agency is somewhat lax in requiring records from the Source for verification of continuous compliance.

SOURCE 5
ELECTROSTATIC PRECIPITATOR
SERVING PULVERIZED COAL-FIRED BOILER

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Pulverized Coal-Fired Boiler
Number of Employees	25
Number of Management Employees	5
Age of Equipment	4 years
Location	Rural

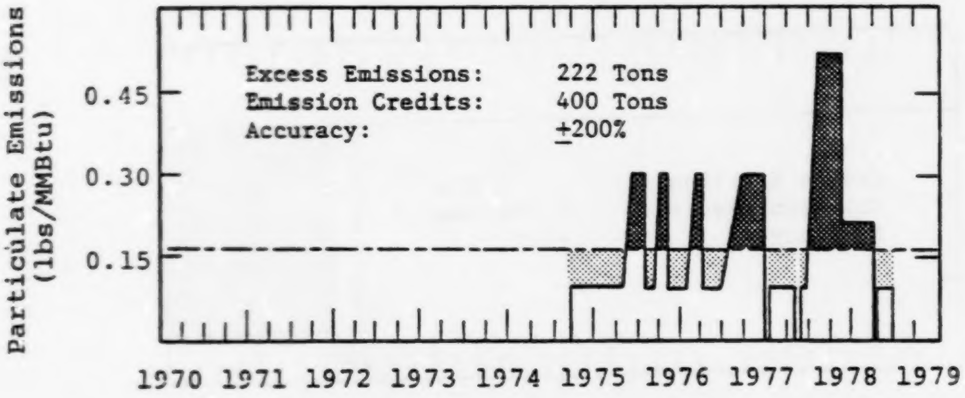
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate (from one unit)	16 tons/hr 32,000 tons/yr
Applicable Regulation	0.16 lb/10^6 Btu

C. Control Device Characteristics

Type of Control Device	Electrostatic Precipitator
Capacity of Control Device	550,000 ACFM @ 275°F
Age of Control Equipment	4½ years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

An electrostatic precipitator is used to control particulate emissions from a 30 year old pulverized coal-fired boiler used for peaking service. Due probably to economic consideration, the precipitator is undersized and operates in excess of allowable emission rates 50% of the time. There is a good working relationship between the Source and the Agency, however, the field inspector has not identified some of the excess emission incidents.

SOURCE 6
ELECTROSTATIC PRECIPITATOR
SERVING KRAFT PULP MILL RECOVERY BOILER

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Kraft Pulp Mill Recovery Boiler
Number of Employees	2000
Number of Management Employees	60
Age of Equipment	2 years
Location	Rural

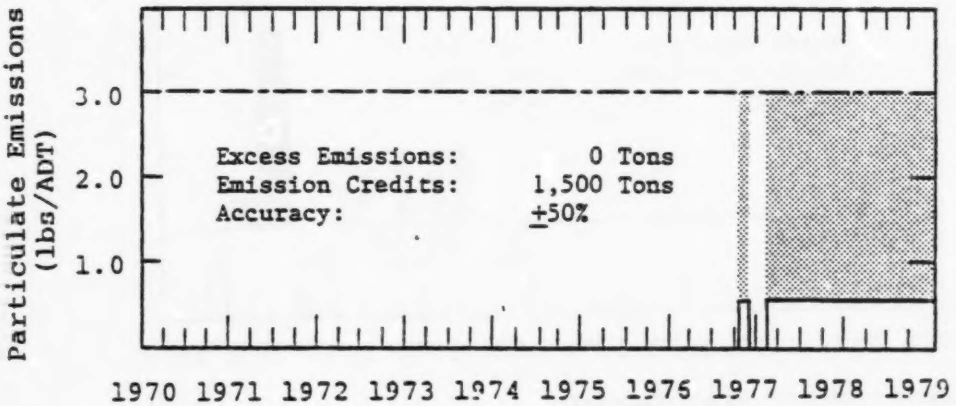
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	26 tons/hr 208,000 tons/yr
Applicable Regulation	3.0 lb. particulate/ton ADP

C. Control Device Characteristics

Type of Control Device	Electrostatic Precipitator
Capacity of Control Device	535,000 ACFM @ 395°F
Age of Control Equipment	2 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

An electrostatic precipitator controlling emission from a kraft pulp mill recovery boiler was inspected. This ESP has a considerable margin of overdesign when considering mass-emissions. The Source has had some problems in maintaining compliance with opacity limitations although stack tests demonstrate that they are substantially in compliance with mass-emissions limitations. The Source is concerned with this because of the superficial nature of State agency's inspection and the inspector's reliance on opacity readings to determine compliance. There are no occasions when the Source should be out of compliance with mass-emissions limitations. We were somewhat disappointed by the lack of operation and maintenance records for the control equipment.

SOURCE 7
VENTURI/IMPINGEMENT SCRUBBER SERVING GREY IRON FOUNDRY CUPOLAS

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Grey Iron Foundry
Number of Employees	200
Number of Management Employees	More than 10
Age of Plant	More than 50 years
Operating Schedule	2550 hrs/yr

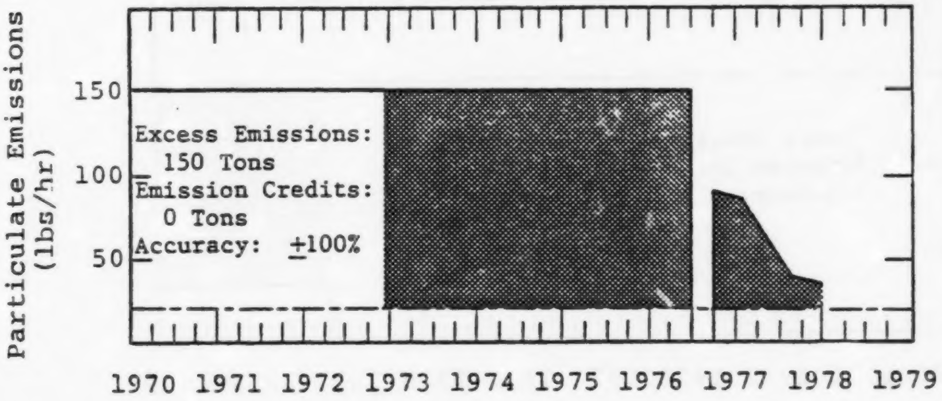
B. Pollutant Characteristics

Type of Pollutant	Particulates
Uncontrolled Emissions	240 lbs/hr 300 tons/yr
Applicable Regulation	22 lbs/hr

C. Control Device Characteristics

Type of Control Device	Venturi/Impingement scrubber
Capacity of Control Device	40,000 Acfm @ 120°F
Age of Control Equipment	5 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

This case revealed an unusual variety of engineering and enforcement problems. Among these problems were an initially uncooperative attitude by the Source, the Source's choice of an inappropriate control system design, failure of State Agency engineers to recognize the inadequacy of this design, control equipment fabrication and construction delays, failure of the design engineering firm to guarantee the equipment design, and a lack of coordination between the State Agency Air and Water Pollution Divisions. The net result of these problems has been continuous noncompliance during the 1970 - 1977 period of study.

SOURCE 8
ELECTROSTATIC PRECIPITATOR
SERVING KRAFT PULP MILL RECOVERY BOILERS

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Kraft Pulp Mill Recovery Boilers
Number of Employees	500
Number of Management Employees	20
Age of Plant	80 years
Operating Schedules	8000 hrs/yr
Location	Commercial/Residential

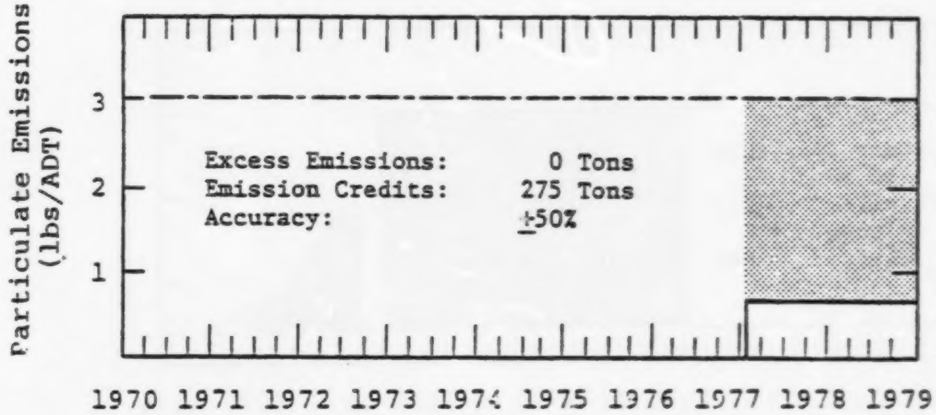
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	#1) 2270 lbs/hr #2) 7200 lbs/hr
Regulatory Requirement	#1) 9080 tons/yr #2) 28,8000 tons/yr 3.0 lb particulate/ton ADP

C. Control Device Characteristics

Type of Control Device	Electrostatic Precipitator
Capacity of Control Devices	#1) 200,000 ACFM @ 325°F #2) 320,000 ACFM @ 475°F
Age of Control Equipment	2 years

II. ANNUAL EMISSION PROFILE



III. SOURCE/AGENCY PERFORMANCE

The Source operates two recovery boilers at this kraft pulp mill, both of which are controlled by electrostatic precipitators The ESPs are well designed and, as demonstrated by the emissions profile, are unlikely to allow the emission level above the compliance limit. The Source has had experience with this combination of equipment at other company facilities which helped prevent design deficiencies from being incorporated into these units. The preventive maintenance programs and recordkeeping practices of the Source are very good. The Agency felt that this Source exemplifies what performance level is possible from the combination of good design and preventive maintenance. The Agency's inspections appear to be comprehensive and the working relationship between Agency and Source is very good.

SOURCE 9
WET CYCLONE
SERVING ROTARY DRYER

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Gas-Fired Rotary Dryers
Number of Employees	∼50
Number of Management Employees	Less than 10
Working Schedule	2,500 hrs/yr
Location	Low Density Residential

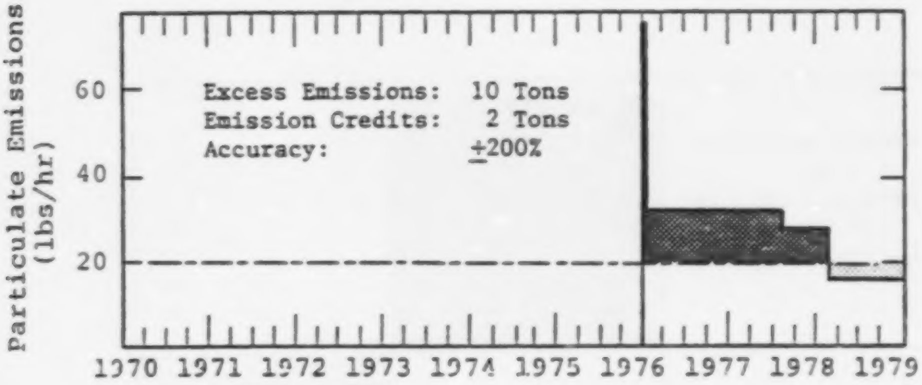
B. Pollutant Characteristics

Type of Pollutant	Particulates
Uncontrolled Emission Rate	420-900 lbs/hr
Regulatory Requirement	30.5 lbs/hr

C. Control Device Characteristics

Type of Control Device	Two-stage Wet Cyclone
Capacity of Control Device	20,000 ACFM @ 200°F
Age of Control Equipment	2½ years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The Source is owned by a small firm that has little experience in pollution control. Nevertheless, the firm designed and installed its own control equipment. This equipment does not appear to be capable of achieving the required control efficiency. The equipment may also suffer corrosion/abrasion failures in the future. The Agency has recorded several opacity violations at the Source and it intends to perform a stack test. The Source reportedly emits traces of asbestos, but it is not subject to present NESHAPS regulations.

SOURCE 10
CARBON ADSORPTION BED SYSTEM SERVING TEXTILE FINISHING OPERATION

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Textile Finishing
Number of Employees	30
Number of Management Employees	5
Age of Equipment	25 years
Location	Commercial/residential
Operating Schedule	2000 hours/year

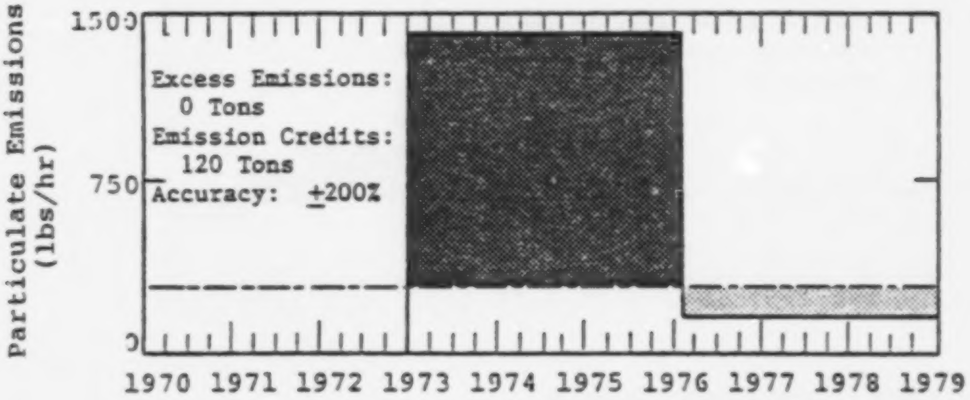
B. Pollutant Characteristics

Type of Pollutant	Hydrocarbon vapors
Uncontrolled Emission Rate	1400 pounds/hour 1400 tons/year
Applicable Regulation	85% control

C. Control Device Characteristics

Type of Control Device	Carbon bed adsorpers
Capacity of Control Device	30,000 ACFM
Age of Control Device	2 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The control system has operated in continuous compliance since it was installed. Excess emissions occurred only during a two-day period when minor repairs were being made. The company uses good operation and maintenance practices. Routine inspections performed by the State have been superficial in that no attempt has been made to develop a solvent material balance for the process. A significant fraction of the solvent cannot be presently accounted for.

SOURCE 11
FABRIC FILTER
SERVING HOT-MIX ASPHALT PLANT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Hot-Mix Asphalt Plant (Batch
Number of Employees	More than 50
Number of Management Employees	~5
Age of Plant	2 years
Location	Rural
Operating Schedule	Varies, average 1800 hrs/yr

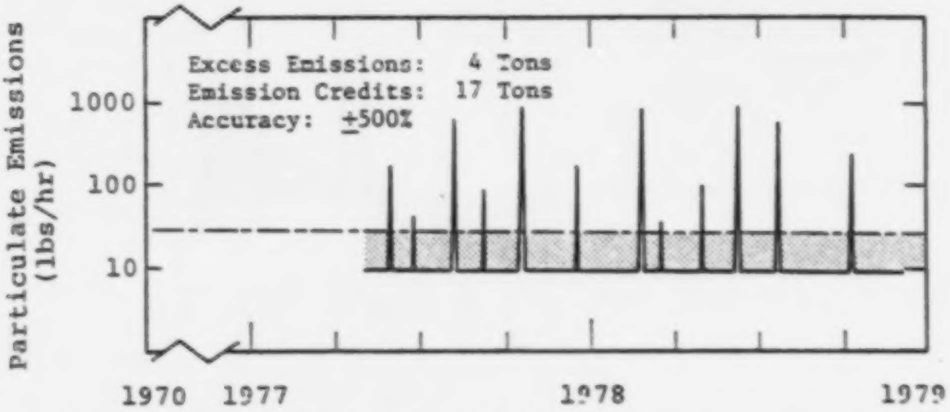
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emissions	7,000 lbs/hr 6,300 tons/yr
Applicable Regulation	45 lbs/hr

C. Control Device Characteristics

Type of Control Device	Reverse Pulse Air Fabric Filter
Capacity of Control Device	30,000 ACFM @ 260°F
Age of Control Equipment	2 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The Source maintains the control system in good working condition and does not appear to violate particulate emission standards. The Source has experienced several maintenance problems, most notably bag tearing, but plant personnel have found solutions to most of the problems. The Source has a good working relationship with the State Agency and is co-operative during all inspections and complaint investigations. Due to the Source's extremely close proximity to several residences, the Agency has installed an ambient air monitor near the Source. For this reason, the Source ceases production during all significant control system malfunctions.

SOURCE 12
CARBON ADSORPTION BED SYSTEM SERVING COMMERCIAL PRINTING OPERATION

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Printing
Number of Employees	60
Number of Management Employees	5
Age of Equipment	35 years
Location	Commercial/residential

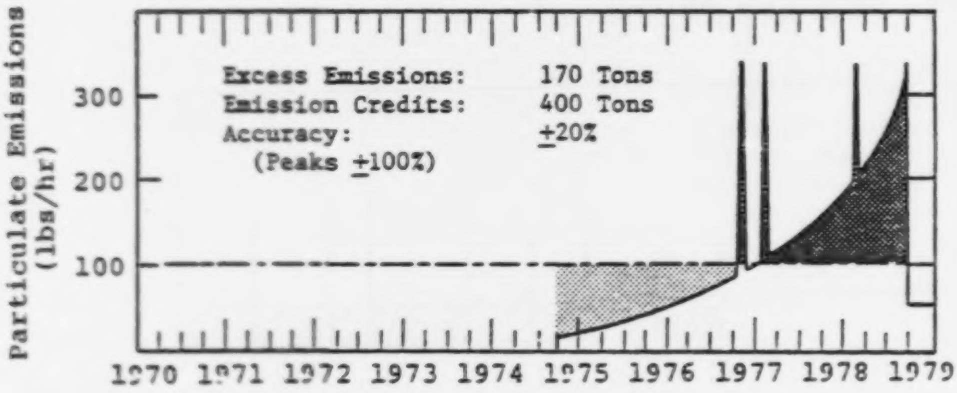
B. Pollutant Characteristics

Type of Pollutant	Hydrocarbon vapors
Uncontrolled Emission Rate	630 lbs/hr 1980 tons/yr
Applicable Regulation	85% control

C. Control Device Characteristics

Type of Control Device	Carbon bed adsorbers
Capacity of Control Device	10,000 ACFM @ 170°F
Age of Control Equipment	5 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The source installed a carbon bed adsorption system in order to continue use of photochemically active solvents that are subject to State regulations. The system performed above expectations until the carbon pellets began to age and the vapor loading on the beds increased. Despite the economic penalty of solvent loss, the management has been slow to correct the overloading of the beds. The inspector failed to recognize the developing overloading problem and to identify the violation which existed for two years on a continuous basis. The system performance has now been improved by the replacement of the carbon pellets.

SOURCE 13
SEVEN ELECTROSTATIC PRECIPITATORS
SERVING TENTER FRAMES

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Textile Finishing Plant
Number of Employees	350
Number of Management Employees	4
Age of Equipment	30 years
Location	Residential

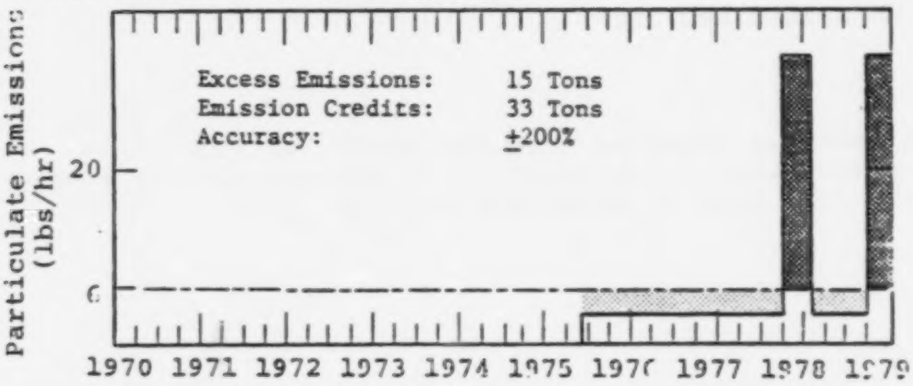
B. Pollutant Characteristics

Type of Pollutant	Nonphotochemically reactive hydrocarbon (particulate)
Uncontrolled Emission Rate	70 lb/hr (all sources) 210 ton/yr (all sources)
Applicable Regulation	Less than 40% opacity process weight regulations (example, 6 lb/hr)

C. Control Device Characteristics

Type of Control Device	2-stage, positive corona ESP
Capacity of Control Device	11,000 ACFM @ 140°F
Age of Control Equipment	3 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The Source has installed 2-stage positive corona electrostatic precipitators, a somewhat unproven control technique for controlling condensible hydrocarbon emissions. Given the alternative methods of control, it is felt that selection of this method was the proper choice at this particular Source. The plant has experienced numerous problems in continued operation of the control equipment. Most of these problems are associated with design deficiencies and with the nature of the emissions. The Company and other textile firms have encountered considerably more serious problems with similar applications of ESPs at other locations. The working relationship between Agency and Source is good and Agency personnel are sensitive to the problems encountered by the Source. Plant personnel have made a conscientious effort to properly operate and maintain the control equipment.

SOURCE 14
BAGHOUSE SERVING STONE PRODUCTS HANDLING (FUGITIVE DUST)

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Stone Products Handling
Number of Employees	45
Number of Management Employees	5
Age of Equipment	28 years
Location	Rural/residential

B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emissions Rate	540 lb/hr 810 tons/yr
Applicable Regulations	< 40% opacity

C. Control Device Characteristics

Type of Control Device	Baghouse
Capacity of Control Device	24,100 ACFM @ Ambient temp
Age of Control Device	25 years

II. ANNUAL EMISSIONS PROFILE

No data was received from the source or found in State agency files which would allow construction of even the most crude type of emissions profile.

III. SOURCE/AGENCY PERFORMANCE

The agency has spent considerable time and effort in bringing this source into compliance with opacity limitations. The source is faced with controlling a fugitive dust problem with a baghouse which is 25 years of age. Furthermore, the source is no longer provided an economic incentive to efficiently capture the particulate matter. At one time the particulate matter was an economically viable product. The state agency has recently induced the source to develop a limited preventive maintenance program which they believe will avert the problems of the past.

SOURCE 15
WET SCRUBBER
SERVING PULVERIZED COAL-FIRED BOILER

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Pulverized Coal-Fired Boiler
Number of Employees	450
Number of Management Employees	5
Age of Equipment	25 years
Location	Commercial/residential

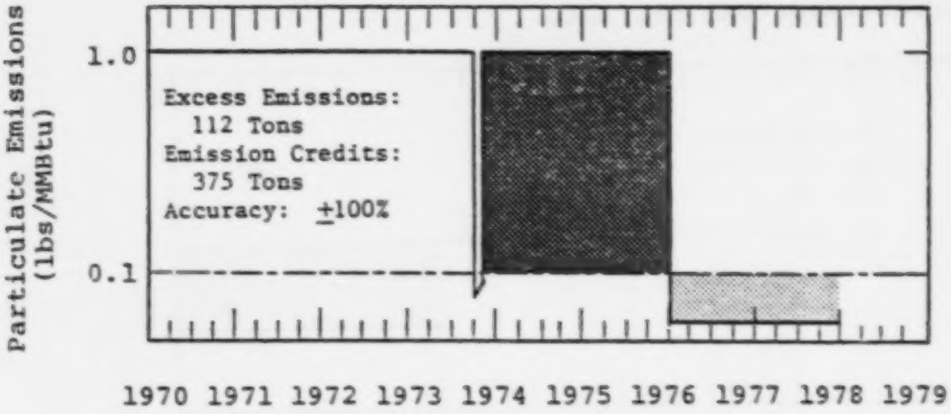
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	405 lbs/hr 842 tons/yr
Applicable Regulation	0.24 lbs/MMBTU

C. Control Device Characteristics

Type of Control Device	Wet scrubber
Capacity of Control Device	25,000 ACFM @ 350°F
Age of Control Equipment	5 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The Company made a good faith effort to comply with particulate emission standards through installation of a wet scrubber of unusual design. Corrosion problems resulted in complete system failure within two months. The Company made the necessary repairs and has been operating in compliance for the past three years. The expeditious and efficient handling of this case can be credited partially to the conscientous attitude of the Company and the voluntary compliance approach of the Agency. However, a more comprehensive permit review program may have identified the corrosion problem before the Company suffered the economic losses involved in replacement of the first unit. This could have prevented the two year period of uncontrolled emissions during which the modified system was installed.

SOURCE 16
VENTURI SCRUBBER
SERVING KRAFT PULP MILL ROTARY LIME KILN

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Kraft Pulp Mill Rotary Lime Kiln
Number of Employees	2000
Number of Management Employees	60
Age of Equipment	2 years
Location	Rural

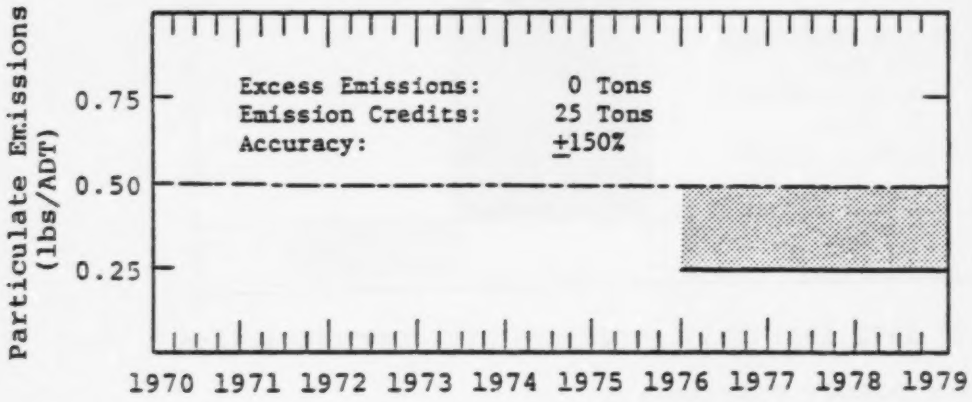
B. Pollutant Characteristics

Type of Pollutant	Particulate
Uncontrolled Emission Rate	6700 lb/hr 26,800 ton/yr
Applicable Regulation	0.5 lb/ton ADP

C. Control Device Characteristics

Type of Control Device	Venturi Scrubber (variable throat)
Capacity of Control Device	33,000 ACFM @ 180°F, AP = 16 in. H_2O
Age of Control Equipment	2 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The venturi scrubber is located at the same plant as Source 6. General comments concerning State agency performance made in the Source 6 report are applicable here. Venturi scrubber controlling emissions from lime kiln has operated successfully with low maintenance requirements. There is no evidence to demonstrate that the scrubber has operated out of compliance with either mass-emissions or opacity limitations. Although the equipment is operated quite successfully, plant personnel keep minimal operation and maintenance records on the control equipment.

SOURCE 17
GAS FIRED INCINERATORS
SERVING TEXTILE FINISHING PLANT

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Textile Finishing Plant
Number of Employees	More than 50
Number of Management Employees	Unknown
Age of Plant	Unknown
Operating Schedule	2,000 hrs/yr

B. Pollutant Characteristics

Type of Pollutant	Hydrocarbons, Particulates, Visible Emissions
Uncontrolled Emissions	Unknown
Applicable Regulation	Opacity control

C. Control Device Characteristics

Type of Control Device	Six Gas-Fired Incinerators (Replaced 7 ESPs)
Capacity of Control Devices	5,000-8,000 ACFM @ 800°F
Age of Control Equipment	1 year

II. ANNUAL EMISSIONS PROFILE

No data was received from the source or found in State agency files which would allow construction of even the most crude type of emissions profile.

III. SOURCE/AGENCY PERFORMANCE

This source has been out of compliance with State opacity regulations during most of the period of study (1970 through 1977). It is also possible that the source has never been in compliance with hydrocarbon emission regulations during this period, but the State agency has not conducted tests to positively identify the pollutant composition. The source originally installed electrostatic precipitators that were rendered ineffective by an unexpected fouling problem. The source found it necessary to replace the original control system with incinerators, thus, suffering a significant financial loss.

SOURCE 18
PACKED BED SCRUBBERS
SERVING TWO ROTARY DRYERS

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Oil-fired rotary dryers
Number of Employees	Less than 100
Number of Management Employees	Less than 10
Age of Plant	Unknown
Working Schedule	120 hrs/wk, 50 wks/yr
Location	Residential/rural

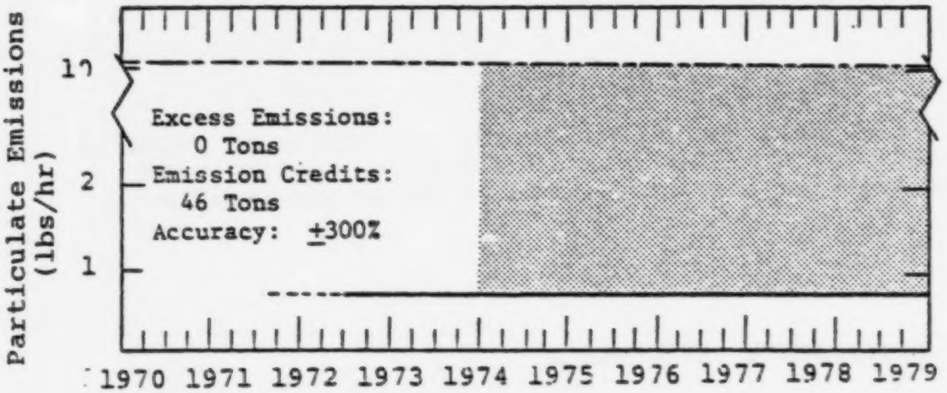
B. Pollutant Characteristics

Type of Pollutant	Particulates
Uncontrolled Emission Rate	300 lbs/hr, 310 tons/yr
Regulatory Requirement	10.2 lbs/hr

C. Control Device Characteristics

Type of Control Device	Packed Bed Scrubbers
Capacity of Control Device	15,000 ACFM @ 140°F
Age of Control Equipment	5 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The Source maintains the control system in excellent working condition and does not violate particulate emission standards. The Source has few maintenance problems with the control equipment. The Source has a good working relationship with the State Agency and is cooperative during routine inspections and complaint investigations. The Agency is somewhat lax in requiring records from the Source for verification of continuous compliance.

SOURCE 19
FABRIC FILTER
SERVING GRINDING AND SAWING OPERATIONS

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	PVC Plant
Number of Employees	Less than 50
Number of Management Employees	5
Age of Plant	5 years
Operating Schedule	2000 hrs/yr
Location	Rural

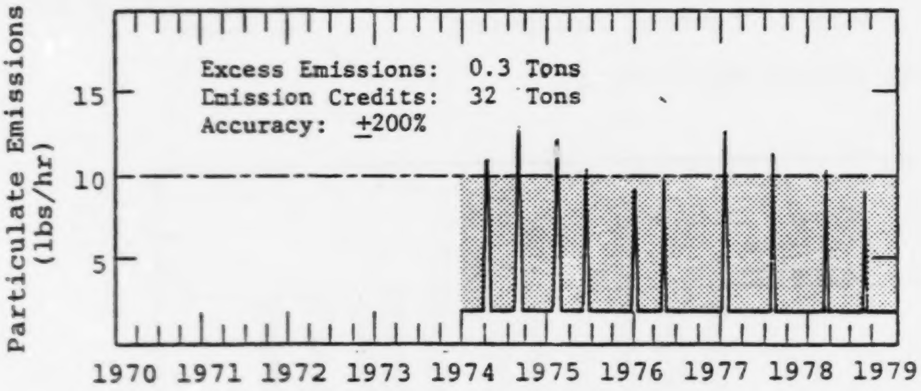
B. Pollutant Characteristics

Type of Pollutant	Particulates
Uncontrolled Emissions	650 tons/yr
Applicable Regulation	10 lbs/hr

C. Control Device Characteristics

Type of Control Device	Shaker Type Fabric Filter
Capacity of Control Device	9,500 ACFM @ 70oF
Age of Control Equipment	4 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The Source maintains the control system in good working condition and rarely violates particulate emissions standards. The Source conducts a responsible maintenance program to keep the fabric filters operating properly. The Source has a good working relationship with the State Agency and is cooperative during routine inspections.

SOURCE 20
VENTURI SCRUBBER SERVING FERTILIZER PLANT AMMONIATOR - GRANULATOR

I. CASE CHARACTERISTICS

A. Plant Characteristics

Type of Source	Fertilizer Plant
Number of Employees	Less than 60 (seasonal)
Number of Management Employees	5
Age of Plant	Unknown
Operating Schedule	130 hrs/wk, 15 - 20 wks/yr

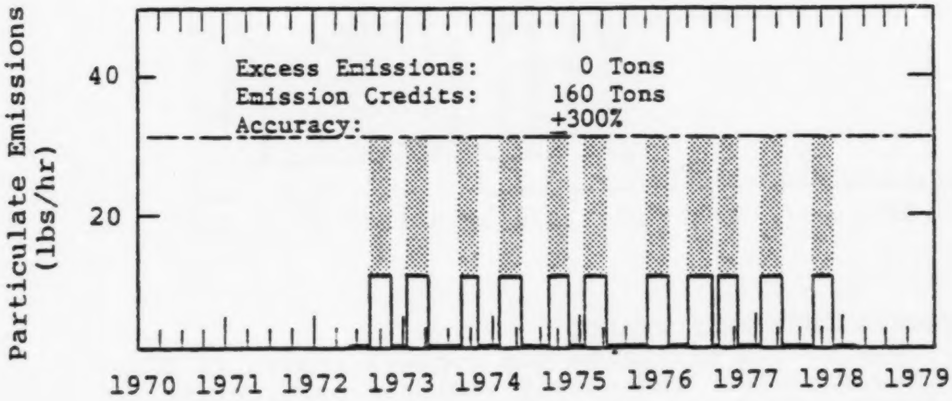
B. Pollutant Characteristics

Type of Pollutant	Particulates, odorous emissions (ammonia fumes)
Uncontrolled Emissions	100 lbs/hr (particulates) 97.5 tons/yr (particulates)
Applicable Regulation	31 lbs/hr (particulates) odorous emissions must be controlled

C. Control Device Characteristics

Type of Control Device	Venturi Scrubber
Capacity of Control Device	6,000 ACFM @ 200°F
Age of Control Equipment	6 years

II. ANNUAL EMISSIONS PROFILE



III. SOURCE/AGENCY PERFORMANCE

The Source maintains the control system in excellent working condition and does not violate particulate emission standards. The Source has few maintenance problems with the control equipment. The Source has a good working relationship with the State agency and is cooperative during routine inspections and during complaint investigations. The Agency is somewhat lax in requiring records from the Source for verification of continuous compliance.

APPENDIX B

SOURCE INSPECTION REPORTS

INSPECTION REPORT

SOURCE 1

1. Summary of Visit

A large cold-side electrostatic precipitator serving a coal-fired utility boiler was inspected. Since start-up four years ago, an extensive series of modifications have been made in order to achieve compliance with particulate mass emission regulations and visible emission limitations. The precipitator has recently achieved compliance after installation of a flyash conditioning system. The records viewed demonstrate a conscientous effort on the part of the source to design and subsequently modify the precipitator. In our judgement the source has taken all reasonable efforts to achieve compliance with air pollution control regulation.

2. Chronology of Source/Agency Interaction

1973 - December. Source applies for permit to operate ESP.

1974 - March. Permit is approved by the State but classifies source under NSPS. Source rejects permit and reapplies noting that construction contracts were let in 1968, three years prior to NSPS regulations.

- May. Permit is approved by the State.

- August. ESP not operating at design efficiency; unit out of compliance with opacity regulations.

- December. ESP not operating at design efficiency; unit out of compliance with opacity regulations.

1975 - February. ESP not operating at design efficiency; unit out of compliance with opacity regulations. Source attempting to rectify the situation by modifying ESP.

- June. Routine inspection determines unit is still out of compliance with opacity regulations.

- *August*. Stack test performed and unit determined to be operating out of compliance with mass emissions limitations.

- *December*. Out of compliance with opacity regulations (routine inspection). Personnel from source and State agency meet to review modifications made to date and to discuss available alternatives for bringing source into compliance. Modifications made thus far have been ineffective.

1976 - *January*. Routine inspection. Unit remains out of compliance with opacity regulations.

- *February*. Meeting held to discuss tentative time schedule to investigate ash conditioning system. Operation with high-sulfur coal to overcome resistivity problems ruled out as a control option but may be needed as a last resort.

- *March*. Company submits proposed compliance schedule for both units to the State.

- *October*. Meeting held between Company and State to discuss preliminary findings and proposed time schedule for ash conditioning system. Test with high-sulfur coal in 8/76 successful in solving resistivity problem.

- *November*. Company sends letter to State confirming discussion of October meeting. Routine inspection, some rappers not working and unit out of compliance with opacity regulations.

- *December*. Request by State for permit modification to accomodate ash conditioning system.

1977 - *January*. Meeting between State and Company; EPA sends observer. Meeting concerned with compliance activities of source. Source provided progress report on ash conditioning system studies.

- *May*. Meeting is held between State, Company, and EPA, to discuss time schedule and special order for altering compliance.

- *June*. Meeting between State, Company and EPA at Regional office.

- July. State consent order modified to conform with some EPA suggestions. Assignment continues on interim limts, phased installation and reporting requests.

- September. State agrees to reverse order, EPA rejects signed agreement.

1978 - January. Meeting held to negotiate an approvable special order for delayed compliance. Ash conditioning system in place and operating. "De-bugging" of system underway. Apparently in compliance with opacity regulations when conditioning system is working. Apparent initial compliance with mass emissions standards.

- March. Stack test conducted; unit operating in compliance with opacity and mass emissions limitations.

- September. EPA agrees to second unit control plan.

3. Plant Description

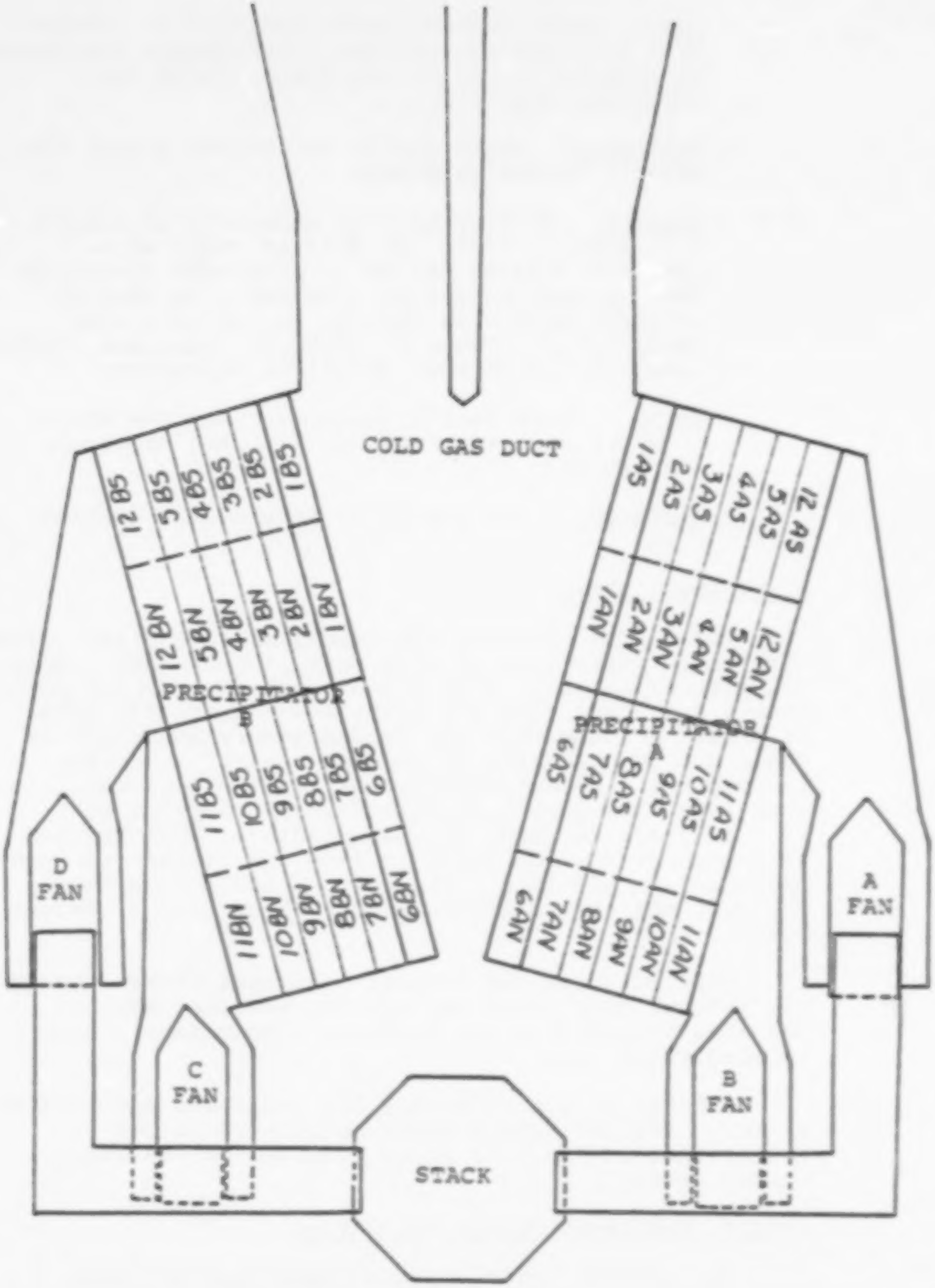
The source operates two identical coal-fired units with rated capacities of more than 1000 MW each. Both are high efficiency, base-loaded systems. Source personnel disclosed that the plant was constructed after it became evident that the needed generating capacity could not be fulfilled by construction of a nuclear power plant. A coal-fired power plant can be built in much less time (approximately 7 years compared with 10 - 15 years for most nuclear plants). Construction of the power station began in 1969 and it was put into operation in mid 1974. The company has a long term contract for low sulfur coal of 0.8% to 1.0% by weight sulfur.

Effluent from the control equipment passes through the induced draft fans and out two 600 feet stacks. The area surrounding the plant is predominantly undeveloped rural land.

A total of approximately 170 employees are located at this station. The Company operates a number of fossil-fuel and nuclear power stations in the geographical region.

4. Control Equipment Design Evaluation

Particulate emissions are controlled by "cold side" electrostatic precipitators. These units are reportedly the largest ESPs constructed by the vendor. Each boiler unit is controlled by 2 ESPs (designated


COLD GAS DUCT
12BS
5BS
4BS
3BS
2BS
1BS
12BN
5BN
4BN
3BN
2BN
1BN
PRECIPITATOR
B
11BS
10BS
9BS
8BS
7BS
6BS
11BN
10BN
9BN
8BN
7BN
6BN
1AS
2AS
3AS
4AS
5AS
12AS
1AN
2AN
3AN
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12AN
PRECIPITATOR
A
6AS
7AS
8AS
9AS
10AS
11AS
6AN
7AN
8AN
9AN
10AN
11AN
D
FAN
C
FAN
STACK
B
FAN
A
FAN

Figure 1. Source 1 Precipitators, Plan View.

A & B) in parallel (see Figure 1). Each ESP consists of two chambers with six fields per chamber. There are a total of 12 TR sets used for each precipitator. These are generally operated in a full wave mode.

As is typical with American type designs, this unit has a weighted discharge wire system. Each precipitator contains 2300 wires (4600 total for each generating unit). Access is available to lower portions of the plates and wires and catwalks are in place at each manhold. However, based on our internal inspection, access to the wires between catwalks is not easily achieved and locating a broken wire may be somewhat difficult. Collector plates are spaced 9 inches apart and are approximately 36 feet long. Four ID fans of one million acfm each are provided on each precipitator for a total air flow of 3 to 4 million acfm. A transmissometer is mounted in the breeching above each fan and the four values are averaged for an average opacity value.

The company has demonstrated a commitment to regulatory compliance by requesting precipitator bids based on coal containing a lower sulfur content than expected. When bids were evaluated, the company requested an additional 30% increase in the specific collecting area (SCA) in order to increase the margin of probable compliance.

The final design was guaranteed by the vendor to be 99.7% efficient (99.6% with one section out of service). Ten months before start-up the vendor indicated the efficiency would be only 99.0% although the unit would be burning 1% sulfur coal (design based upon 0.8% sulfur) at essentially the same conditions as design. The source requested another 44% increase in surface area to achieve "clear stack" conditions and the modifications were incorporated.

With the two design changes the SCA became approximately 300 square feet per 1000 acfm. This is well below the size range we now consider necessary to achieve the collection efficiency of 99.5 to 99.7 with low sulfur coal. The difference between source 5 design and our estimate of SCA requirements is presented in Figure 2. Based on this data it can be conjectured that precipitator performance would be seriously degraded by resistivity problems.

It should be emphasized, however, that the information such as presented in Figure 2 was just beginning

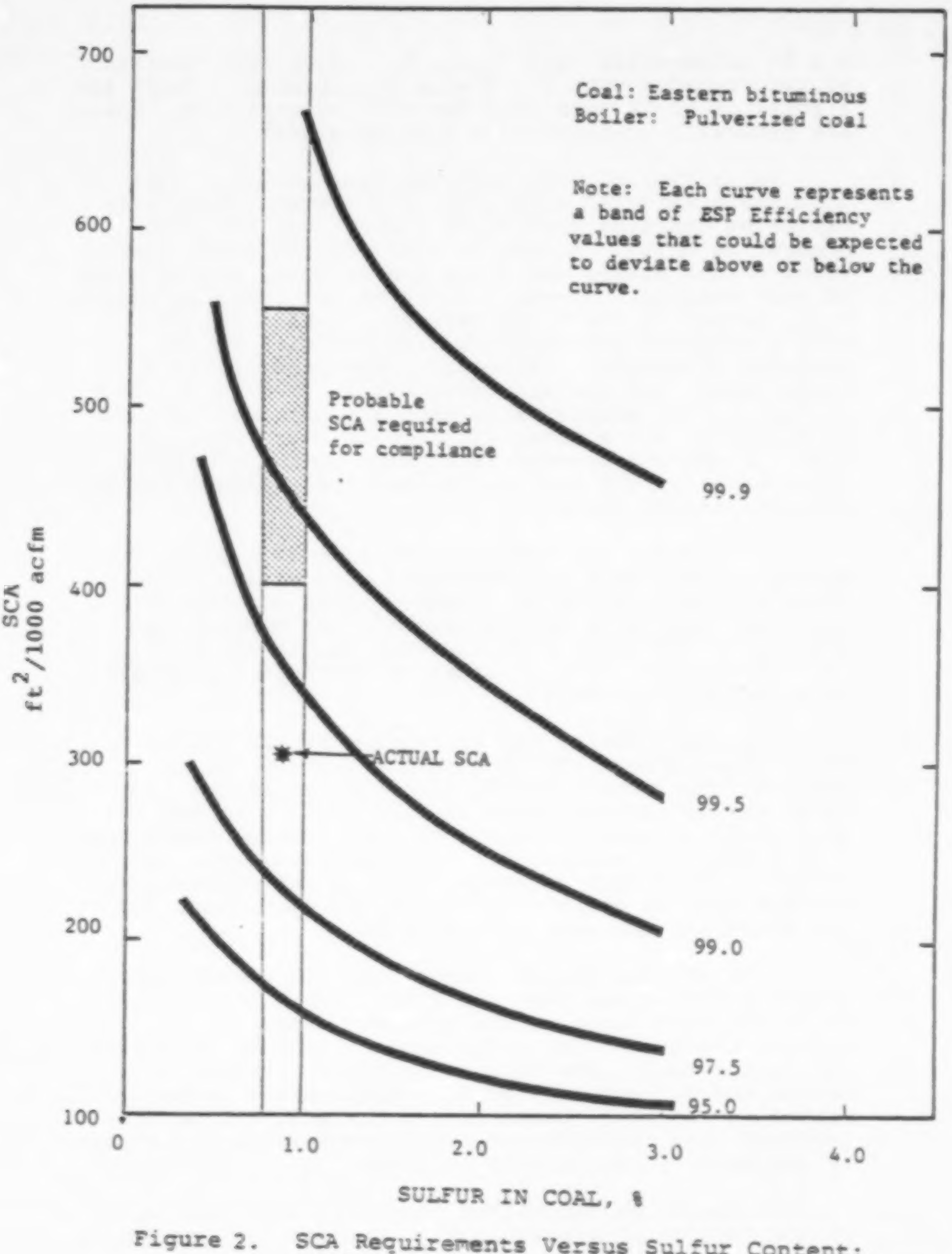


Figure 2. SCA Requirements Versus Sulfur Content: Cold-Side ESP, Pulverized Eastern Bituminous.

emerge in technical literature during the time the ESPs were designed. Furthermore, there is considerable variability in actual SCA requirements for a given installation due to the many factors influencing bulk and surface conductivity (temperature, humidity, coal ash composition, etc.). Neither the vendor nor the company had meaningful engineering guides available with which to size the precipitator for this application. With the benefit of hindsight, it is apparent that either flyash conditioning and/or increased collection area was required. Nevertheless, we believe the units were designed with a good faith effort to comply with regulations. The basis for this opinion include (1) company's insistance on greater SCA than specified by the vendor, (2) the use of 6 fields, and (3) the use of scale model tests to improve gas distribution.

5. Control Equipment Performance Evaluation

5.1 Pre-Compliance Efforts

After start-up of the first unit in late 1974 it was discovered that visible emissions exceeded the 40% limit on a continuous basis. Through the joint efforts of the vendor and the company, a series of modifications were made in an attempt to achieve compliance. Some of these changes are listed below:

(1) Re-adjustment and then removal of turning vanes. This was slightly beneficial. However, the vanes were replaced and are in place at the present time.

(2) Installation of a perforated plate at the inlet to the ESP unit to distribute gas flow. This slightly improved efficiency.

(3) Experiments with rapper intensity and rapping cycle were undertaken. Reentrainment was a problem and addition of more rappers simply added to the problem.

These modifications were undertaken in an effort to achieve compliance without necessitating the extended outage of the boilers and incurring substantial ESP modification costs. When the inadequacy of these and other adjustments became apparent the Company submitted a compliance plan which included SO_3 conditioning equipment for both units. (The processing of this and subsequent compliance schedules is discussed in Section 5.5.) This warranted substantial additional costs.

In September 1976 special tests were performed to confirm that flyash resistivity was, in fact, the principal cause of continuing noncompliance. A unit train quantity of 2% sulfur coal was burned to test impact on effluent opacity. Over a period of 12 to 24 hours after switchover, the power density in the precipitators increased 25% and the average opacity decreased from 60% to less than 10%. The results are reasonably conclusive evidence of resistivity effects.

After installation of the SO_3 conditioning system in February 1978, significant improvements in visible emissions are reported. The SO_3 conditioning system consists of a sulfur burner to form SO_2 (@ 1200 - 2500°F), a gas cooling and dilution section (3% - 6% SO_2 @ 800°F), and a catalytic converter which uses a vanadium oxide catalyst to convert SO_2 to SO_3 (@ 1000°F). The SO_3 is distributed across the flue gas and condenses as a thin film on some flyash particles, thus, enhancing overall resistivity characteristics. When the system was first put into operation a concentration of 30 ppm was used. However, this "overconditioned" the particles and they were easily reentrained after collection. This problem has required a readjustment of the rappers as well as a decrease in the SO_3 level. The present level of 6 - 7 ppm is obtained by operating at the minimum sulfur burn rate in manual control; this practice has presented some problems. Operation at the minimum burn rate has sometimes caused the plugging of the sulfur supply lines due to "freezing" of the liquid sulfur. However, operation of the ESPs since the conditioning system installation has been termed successful. Comparison of power density data and opacity both before and after installation confirms this conclusion. The operators are still in the process of optimizing the system but generally the precipitator has operated in
compliance since January 1978 (see Figures 2 and 3). Installation of a similar conditoning system on the second boiler has recently been completed. It should be noted that the installation of both systems was done 3 to 6 months ahead of the schedule proposed by the Company in their first compliance schedule submitted in March 1976.

5.2 Post-Compliance Efforts

5.2.1 Preventive Maintenance

During the pre-compliance period, the Company instituted a preventive maintenance program to assure more reliable operation of control equipment. Some of the items included in the program are listed below:

Each Shift

- A. Check ash removal system operation
- B. Empty hoppers near end of shift
- C. Check all control cabinets

Each Day

- A. Record in precipitator log
  - 1. Control cabinet meter readings
    - a) Primary AC Voltage
    - b) Primary AC Current
    - c) Secondary DC Current
    - d) Spark Rate
  - 2. Gross MW, opacity, gas temperature, O_2, other data as needed

- B. Check off in log sheet after inspecting
  - 1. Rapper controls and operation
  - 2. Hopper vibrator operation and control
  - 3. TR oil temperature, level, and leaks
  - 4. Arcing in TR ground enclosures, bus ducs, coffins, and cans
  - 5. Damage to flex connectors

- C. Adjust control cabinets

Each Week

- A. Clean cabinet filters
- B. Correlate opacity charts with precipitator records
- C. Opacity monitor checked:
  - 1. Dump pre-filter bowl
  - 2. Change or clean filters
  - 3. Clean lenses
  - 4. Check/adjust alignment
  - 5. Check automatic grain control level
  - 6. Check blower motors
  - 7. Check/adjust recorders in control room

Each boiler unit has a schedule outage about once a year and much of the repair work (wire replacement, plate washing and alignment, etc.) is done at that time. Because this plant is a base-load facility, TR section trip-outs due to broken wires or other short-circuits cannot be attended until the unit goes off-line. The electrostatic precipitator is designed to operate in compliance when 1 TR set is deactivated. (The severity of the impact of additional TR set outages on mass emissions is a complex function of the location of the sets.) The source receives additional help from the headquarters based maintenance personnel during outages.

A troubleshooting guide, which will not be presented in this report, has been developed for the hopper and ash discharge system to diagnose problem areas and to determine necessary corrective actions. This guide exists both as written instructions to maintenance personnel and as a flow-chart. We have not attached this information with the report for several reasons:

1. As any troubleshooting guide should be, it is specific to the installation. We would not recommend indiscriminate use at other plants.

2. We have not received company permission to release this information.

The preventive maintenance program and troubleshooting guide compare favorably with those suggested by some vendors. Our cursory internal inspection of the precipitator indicated the unit was in reasonably good condition.

5.2.2 Recordkeeping

The source maintains extensive records on the precipitator performance. Records maintained include daily TR set readings, spark rates, boiler load, air and water flow, opacity readings from each fan during TR readings, and occasionally temperature readings.

Each ID fan is equipped with a transmissometer and the readings of all four are averaged to give an average stack opacity. However, the strip charts were discovered to be nearly impossible to read. The monitors meet all specifications of Performance Specification 1 (40 CFR 60, Appendix B) including the 10-second response time. This fast response time and the nature of the strip chart recorder produce something more like a bandwidth reading rather than discernible points vs. time. Thus, determining an average opacity from the charts at any specific time would likely have an error of ±30 percent opacity. The cause of this wide variation in opacity is most likely rapping. There is a certain amount of reentrainment which the transmissometer sees as "puffs" and records as spikes on the strip chart. The source recently installed a computer program which takes the readings of the four transmissometers, averages them over 6 minutes and provides a strip chart reading with a running 6 minute average and 10 second update. The effect of this running average is to smooth the strip chart read-out of opacity to reflect an integrated average. This system should prove useful both to the source and the State in determining when opacity exceeds the 40% limit.

Maintenance work-orders and invoices are also kept on file. These files are not as easily interpretted as the opacity and TR set data but may be "tracked" to identify problems with the ESP.

The recordkeeping policies of the Company appear consistent with standard practices. While these are adequate we would recommend several minor revisions as listed below:

1. Record location of wire breakages in order to diagnose alignment problems or other factors. Those records should also indicate whether the break was due to electrical or mechanical conditions.

2. Record changes in rapper sequences and intensities.

3. Record changes in hopper discharging cycles.

4. Record results of air-load tests in a bound notebook.

While these practices could conceivably lead to improved efficiency, the primaty purpose of the above records is to reduce maintenance time requirements.

5.2.3 Emissions

Two source tests have been performed on the precipitator, one in August 1975 and one in March 1978. Both tests were performed at similar operating conditions. There is some difference in the ash and sulfur content of the coal. However, the conditioning system seems to be primarily responsible for the increased collection efficiency. Furthermore, the first stack test shows slightly more than double the emissions rate than the most recent stack test (.2076 lb/106 Btu vs. .088 in 1978).

Summary of Emissions Tests

Average	8/75	3/78
Input Btu/hr	9146	9896
ACFM	3,930,530	3,681,999
Ash Content (1%)	11.99	9.71
Sulfur Content (1%)	1.09	0.93
Emissions 16/10^6 Btu	.2076	0.088
% Efficiency	97.38	98.4

It should be noted that the stack test method is a modified Method 5 using an in-stack filter. Furthermore, because of the size of the unit it takes approximately two points per run. Testing is accomplished by simultaneously sampling downstream of the ID fans and upstream of the precipitator and the test is split so that first one side (e.g., precipitator A) is tested and then the other side (e.g., precipitator B) and the results combined.

An annual average emission profile has been prepared based on the limited information available. As shown in Figure 3, mass emissions are assumed to be presently in the

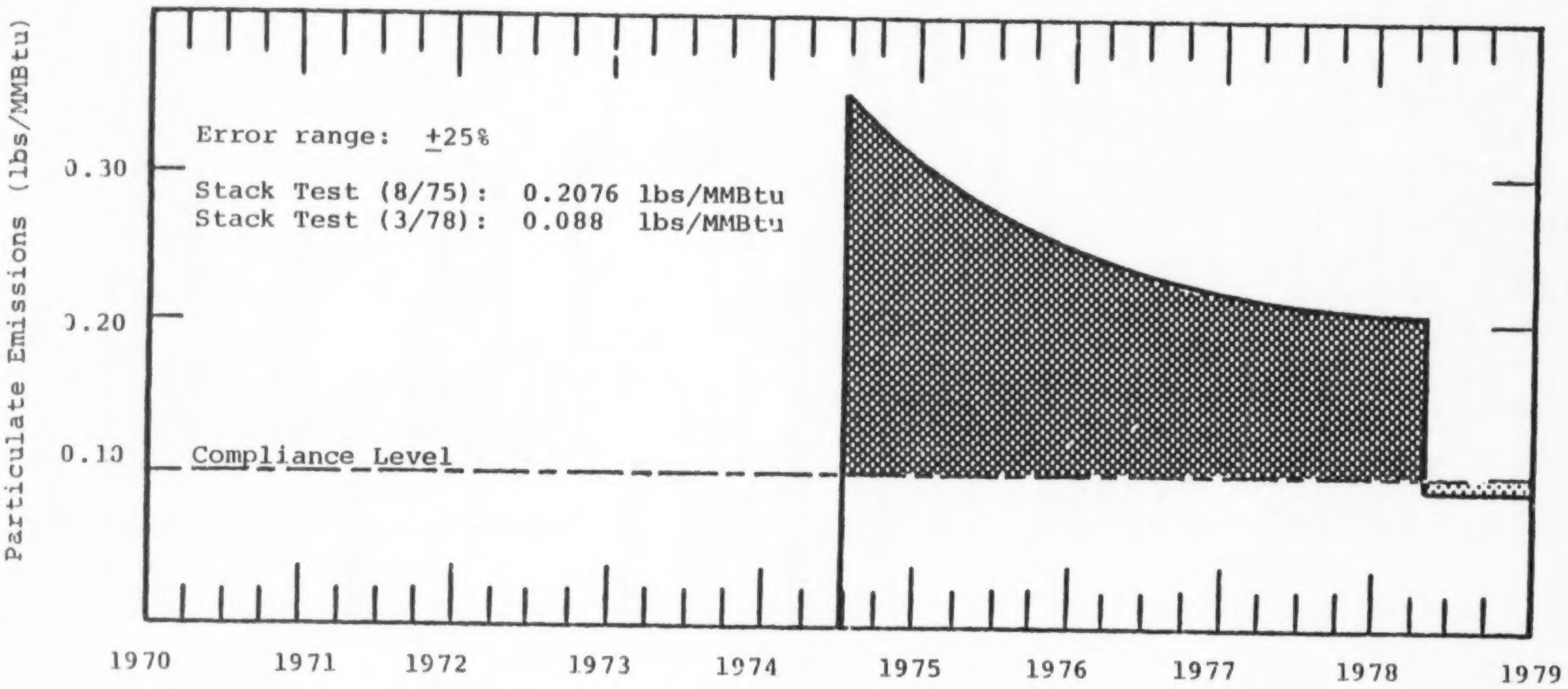


Figure 3. Estimated Annual Emissions Rate for Source 1.

range of 0.09 LBS/MMBTU after installation of SO_3 conditioning equipment. Pre-compliance emissions are depicted as having a negative slope asymptotically aproaching a limit of 0.20 LBS/MMBTU. This initial drop in emissions is credited to gas flow and hopper adjustments. The steep drop in emissions is due to SO_3 conditioning. The general trends shown in Figure 3 are based on somewhat sketchy opacity readings in various agency files. Our estimates of the potential error is illustrated by the band of stipling.

A diurnal emissions profile is provided in Figure 4. The data shown is based on average transmissometer readings for an early 1978 summer day. Plant personnel indicated that this period is most representative of normal operation. We have again included an estimation of the potential errors.

It should be noted that the company voluntarily attempted to minimize total emissions during the pre-compliance period by load reduction. These reductions cannot be adequately shown on Figure 3 since the emission rate is in pounds per MMBTU fuel input.

5.4 Spare Parts Inventory

The company provided a rather detailed list of spare parts. This list is provided below in condensed form.

Ash System

1) Feeder housing body
2) Gaskets
3) Bearings
4) Valves (assemblies)
5) Various gate valves
6) Solenoid valves
7) Cycloblower

Precipitators

1) Wire assemblies
2) Insulators
3) SCR's
4) Rectifiers
5) Rappers components
6) Gaskets
7) Spare firing circuits
8) Panel meters

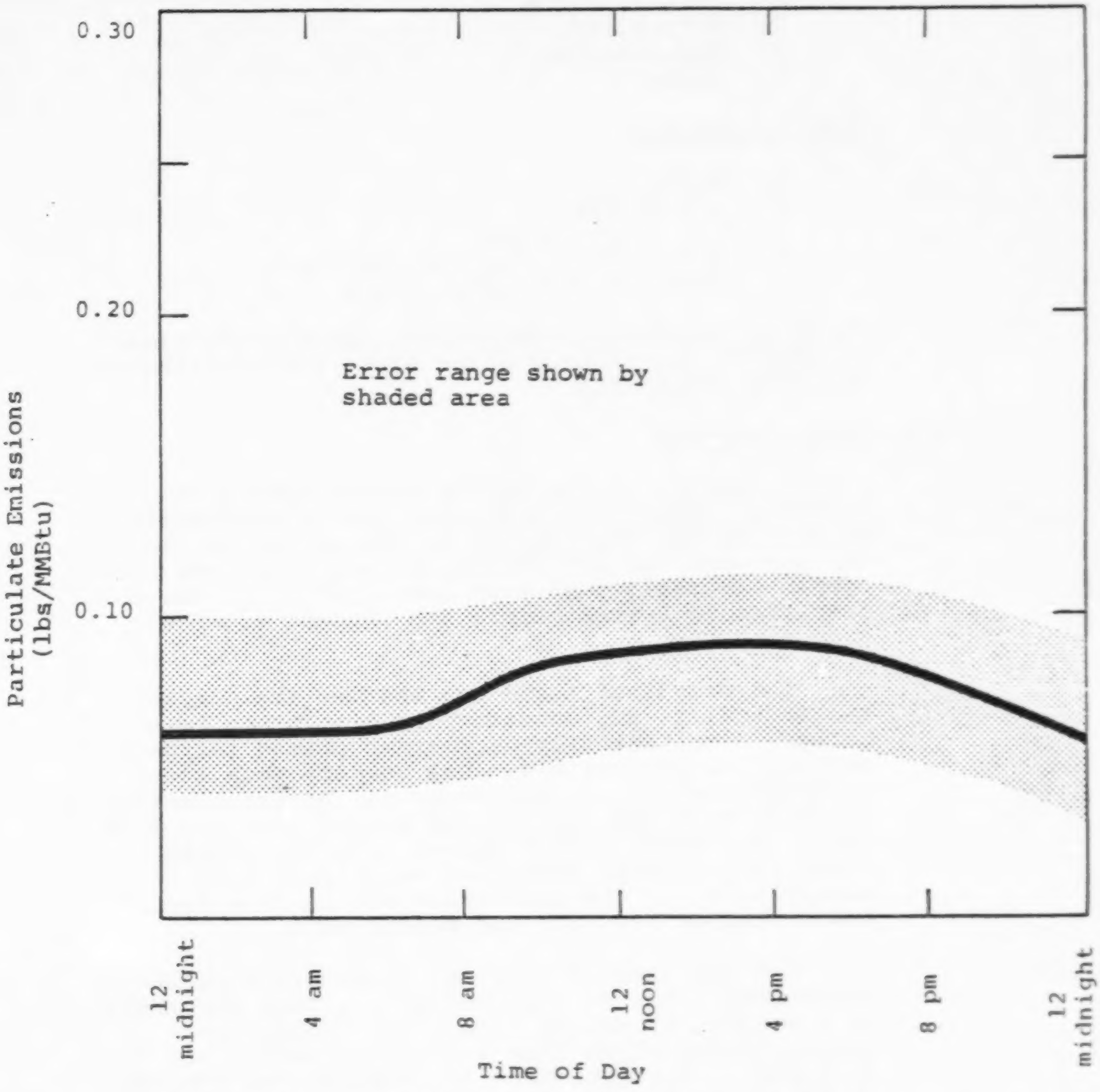


Figure 4. Estimated Diurnal Emissions Rate for Source 1.

Conditioning System

1) Potentiometers
2) Control cards
3) Controller
4) Themocouples
5) Seals

Opacity Monitors

1) Bulbs
2) Air blower
3) Air blower hoses
4) Reflector holder and housing
5) Numerous additional parts

Based on available information, there is no reason to believe the lack of spare parts has contributed to excess emissions.

5.5 Other Comments

A cursory review of the source/agency interaction chronology indicates that considerable difficulty was experienced by the source in receiving approval for compliance modifications. The company actually completed installation of the SO3 conditioning system before the Consent Order was signed by EPA.

The principal issue was whether the Company had to install SO_3 conditioning systems on both boilers simultaneously or whether phased introduction was permissible. The Company took the position that SO_3 conditioning may be unsuccessful in which case the cost of the second unit could be lost. The State agency agreed with the phased installation which specified compliance date of August 1978 for the unit addressed in this report and September 1979 for the second unit.

EPA declined to send any responsible representatives (only an observer with a tape recorder) to a meeting of senior agency and Company personnel during which time a final agreement was to be signed. Subsequently, the Company was advised by EPA that phased installation was not expeditious (alternative compliance date for second unit not suggested by EPA).

During the next 16 months, numerous meetings with EPA were unsuccessful in resolving disagreements concerning phased installation and interim emission limits. The company continued installation of the first unit 6 months ahead of schedule and attempted to minimize emissions on the second unit. Finally, in September 1978 agreement on the second unit was reached. The specified completion date is July 1, 1979, just 2 months earlier than that proposed by the company in 1976. (Actual installation is preceeding 6 months ahead of schedule.)

The point of this discussion is that the particular EPA office made the decision that phased introduction of new technology is not permissible in this case. We are surprised by this action since flyash conditioning is generally not considered off-the-shelf, proven technology. Furthermore, there appear to be some unnecessary internal delays within EPA in the handling of proposed compliance schedules. Perhaps this could be minimized by more senior EPA personnel dealing directly with senior Company representatives.

6. Costs

A rough estimate of costs was provided both for construction of the control equipment plus the costs of its operation and maintenance. These costs do not reflect total costs to the source because some costs were allocated to accounts other control equipment. Capital costs are presented in Table 1 and annualized costs are presented in Table 2. These costs are presented as transmitted to us at the plant meeting. We believe that most cost items are extremely low and must question validity of the data.

Table 1
Capital Costs of Electrostatic Precipitator
(One Boiler)

1.	Purchase, erection, and initial modifications	$ 5,200,000
2.	ESP modifications	27,000
3.	Environmental monitoring system	50,000
4.	Flyash conditioning	805,000
		5,082,000

Even simplistic cost models indicate the installed cost of the ESP (item 1) should be more than $20,000,000. We assume the ESP modifications are low since most repairs were done by the vendor under warranty. The transmissometer costs (item 3) appear low by a factor of 3.

The conditioning system costs (item 4), which are low by a factor of 50% - 100%, are also due to unreported vendor costs and the fact that the conditioning system was installed under the vendor's performance warranty.

The operating costs presented in Table 2 appear somewhat more reasonable although we have not compared values with our computerized cost models due to lack of time. Unfortunately, these costs are provided as a total for both units.

Table 2
Annualized Costs
(Both Precipitators)

Year	Hours Energized	Labor Costs Operators/ $	Maintenance $	Materials $	Energy $	Opacity Monitor Maintenance $
1974	2,811	NA	4,879	4,083	33,391	NA
1975	6,117	NA	27,634	12,384	106,186	NA
1976	14,041	54,978	29,100	9,418	270,270	6,000
1977	13,593	83,000	46,244	8,213	324,600	8,400

During the period of July through December, 1979, approximately 14,000 MW-hours production were lost due to load reduction to maintain opacity below 40%. The costs of these generating reductions are estimated to be approximately $47,000 which represents the additional costs of using less efficient generating units elsewhere in the system.

INSPECTION REPORT

Source 2

1. Summary of Visit

The plant's two rotary dryers have generally been in compliance with applicable particulate and visible emission regulations during the period from start-up in 1972 to mid 1977. However, in 1977 the State Agency Water Quality Division required the source to recirculate scrubbing water, a practice which has led to severe corrosion problems in the scrubbers. The entire scrubber shell was replaced in March 1978. On the date of the inspection, the system was in an advanced state of decay. Severe corrosion had again caused large holes in the shell allowing some gas shortcircuiting. The structural integrity of the scrubber is presently in question. Major repair or replacement may be necessary to re-establish compliance.

2. Chronology of Source/Agency Interaction

1972 - April. Source applies for a temporary permit.

- August. Agency visits plant and finds emissions to be in violation. Agency recommends that the source make alterations to the scrubbers. Temporary permit issued allowing source ten months to correct the situation.

- September. Permit issued. Apparent initial compliance with mass emissions regulations.

- December. Inspection finds source to be in compliance.

1973 - March. Complaint received by Agency about the source. The complaint was about the plant's occupational environment rather than emissions.

- April. Local congressman forwards several other citizen complaints to the Agency. Agency informs him that the source is working on corrective measures. (Offending process is not the dryers.)

- May. Another complaint received by the Agency. Plant visited and found in compliance for process emissions. Agency noted a fugutive dust problem from loading and transport operations.

- November. Source visited. Dryer scrubbers found to be in compliance. Another process at the plant was found to be in violation.

1975 - December. Permit renewed.

1976 - March. Source visited; found to be in compliance.

- August. Source visited, plant not operating.

- October. Inspection reveals corrosion holes in scrubbers.

- December. Permit revised to include changes in other control equipment.

1978 - March. Scrubbers replaced.

- July. Source visited; found to be in compliance.

NOTE: Information for 1974 and a portion of 1975 was missing from the Central and Regional office files. Based on interviews with the Agency personnel and source representatives, we believe that the source was inspected on a quarterly basis and found in compliance on each occasion.

3. Plant Description

This plant produces ground mineral products and quartz sand from ores mined from nearby deposits. Ores are first wet rod milled, separated, and drained. Drained materials (approximately 25 mesh) are transferred into rotary dryers that are fired with No. 2 oil. Materials are introduced into the dryers countercurrent to the burner exhausts. Exhausts from each dryer first pass through an eight foot diameter cyclone, a forced draft fan then the wet cyclonic scrubbers. The wet scrubbers operate under slight positive pressure due to the downstream location of the fan.

Each scrubber is five feet in diameter and contains eight spray nozzles at each of three levels. Each scrubber handles approximately 9,000 acfm at temperatures up to 325oF, and uses approximately 40 gpm of water. Pressure drop through the scrubbers is approximately 4 inches of water. These scrubbers may be properly classified as low pressure drop systems of limited effectiveness for particles less than 5 to 10 microns.

Water for the scrubber was originally once-through, but it has been recycled since 1977 to comply with water quality regulations. Recycling of the water causes normally dilute acids (H_2SO_4 from traces of sulfur in the burner oil and HF from traces of flouride in the ores) to become more concentrated. This phenomenon has greatly accelerated corrosion of the mild steel shell of the scrubbers. The prevaling pH of the recirculating liquor is less than 4.0.

Process and Control Equipment Design Evaluation

The scrubbers presented only minor corrosion problems before the scrubbing water was recycled. Since that time a series of serious corrosion failures has occurred, definitely resulting in emission violations. When the scrubber vessels first suffered corrosion penetrations, they were repaired by welding mild steel patches over the affected areas. Problems continued and the scrubber vessels were replaced, first with mild steel lined with epoxy, and then with heavier gauge mild steel. Neither style of construction was successful against corrosion. The source is presently considering replacing the scrubber vessels with wood-lined mild steel.

The choice of the wet scrubber system for the rotary dryers was appropriate before water quality issues were raised. The system could easily meet State particulate regulations and generally met opacity regulations. However, with the present unresolved corrosion problems and continued concerns about water quality, it might be worthwhile for this source to consider a dry type collector such as a fabric filter. Previously, the source rejected fabric filters because of capital cost and maintenance time requirements.

In summary, the present control system is not appropriate for the conditions now encountered at the plant. The source must either find a corrosion resistant material for the scrubber vessels, control the pH of the scrubbing water, or replace the scrubbers with another type of control device.

Performance Evaluation

5.1 Preventive Maintenance

There is no well defined preventive maintenance program for the two scrubbers. Scrubber maintenance seems to have a much lower priority at the plant than process equipment. The plant manager indicated that corrosion penetrations of the scrubber vessels were repaired whenever they were of sufficient size to seriously affect scrubber performance. We suspect that an additional motivating factor is the problems of acid spray fallout from scrubber blow-by to rail sidings below.

The plant manager indicated that spray nozzles were replaced as needed, but he was not able to provide an estimate of the frequency of nozzle replacement or the man-hours devoted to scrubber maintenance. It is apparent that the severe corrosion problems have increased maintenance costs beyond initial expectations.

5.2 Recordkeeping

No data is recorded. This is due in part to a lack of instrumentation such as emissions monitoring devices, differential pressure gauges, fan motor ammeters, temperature indicators, and water flow meters. In addition, the State Agency has not asked the source to submit any records, despite a permit stipulation that authorizes the Agency to require them. As a result, no log book is maintained. This is a deficiency in source operating practices which may be partially explained by the lack of sufficient manpower. Source personnel should have measured pH daily.

It should be noted that there are no records to indicate that the source has notified the Agency of the recently encountered problems. Either malfunction reporting requirements are ignored by both the source and the Agency or the Agency has failed to keep proper telephone call records.

5.3 Emissions

No stack tests have been conducted on the scrubbers by the State during the period of study. The State Agency has estimated that uncontrolled particulate emissions would be about 250 lbs/hr. This estimate is based on AP42 emission factors and is subject to substantial error since the ore handled is different than those considered in the manual. Regulations require particulate emissions to be less than 16 lbs/hr.

Although precise quantification of particulate emissions is not possible, a few general conclusions can be drawn. During the six months following the initial permit application in April 1972, the source probably was not in compliance.

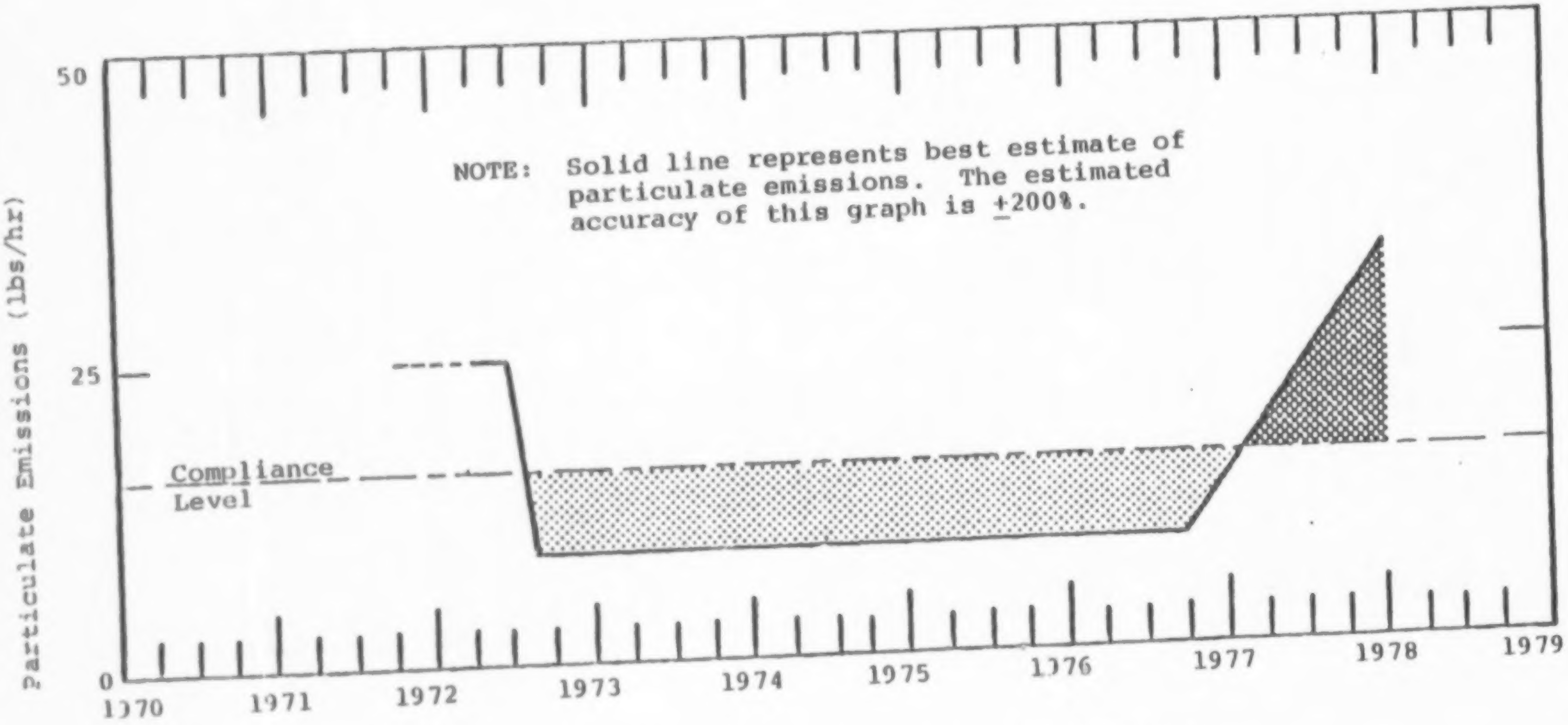
This is based on the State Agency's visual inspection in August 1972. Emissions during this period were probably above 16 lbs/hr, but considerably less than 250 lbs/hr. Beginning in September 1972, the source was probably in compliance most, if not all, of the time. This period of nearly continuous compliance ended in 1977 when corrosion problems began. Since 1977 the source may have been out of compliance for long periods of time.

A rough approximation of particulate emissions during the period 1972 through 1978 is shown in Figures 1 and 2. The error ranges associated with these estimates are also shown. Based on the observed blow-by of gases through large corrosion penetrations of the scrubber shells, we estimate that, since late 1977, emissions may have reached 100 lbs/hr on a continuous basis. These estimates are subject to an error of -50% and +200%. The diurnal profiles reflect our judgement that start-up each week does not contribute emissions above those assigned to blow-by. With a more comprehensive monitoring of source operating procedures we believe that most excess emissions from this source could have been avoided. This would also have saved the source the financial penalties of system repair and possible replacement.

When considering the performance of the source, it should be noted that the unit probably operated at lower than required emission levels for 3 to 4 years. If the difference between compliance and emissions were tabulated for this period, it would probably exceed the total quantity of excess emissions resulting from the recent corrosion problems. This is not offered as an excuse for the source, but simply as a more realistic perspective on the company's good faith effort to operate in compliance.

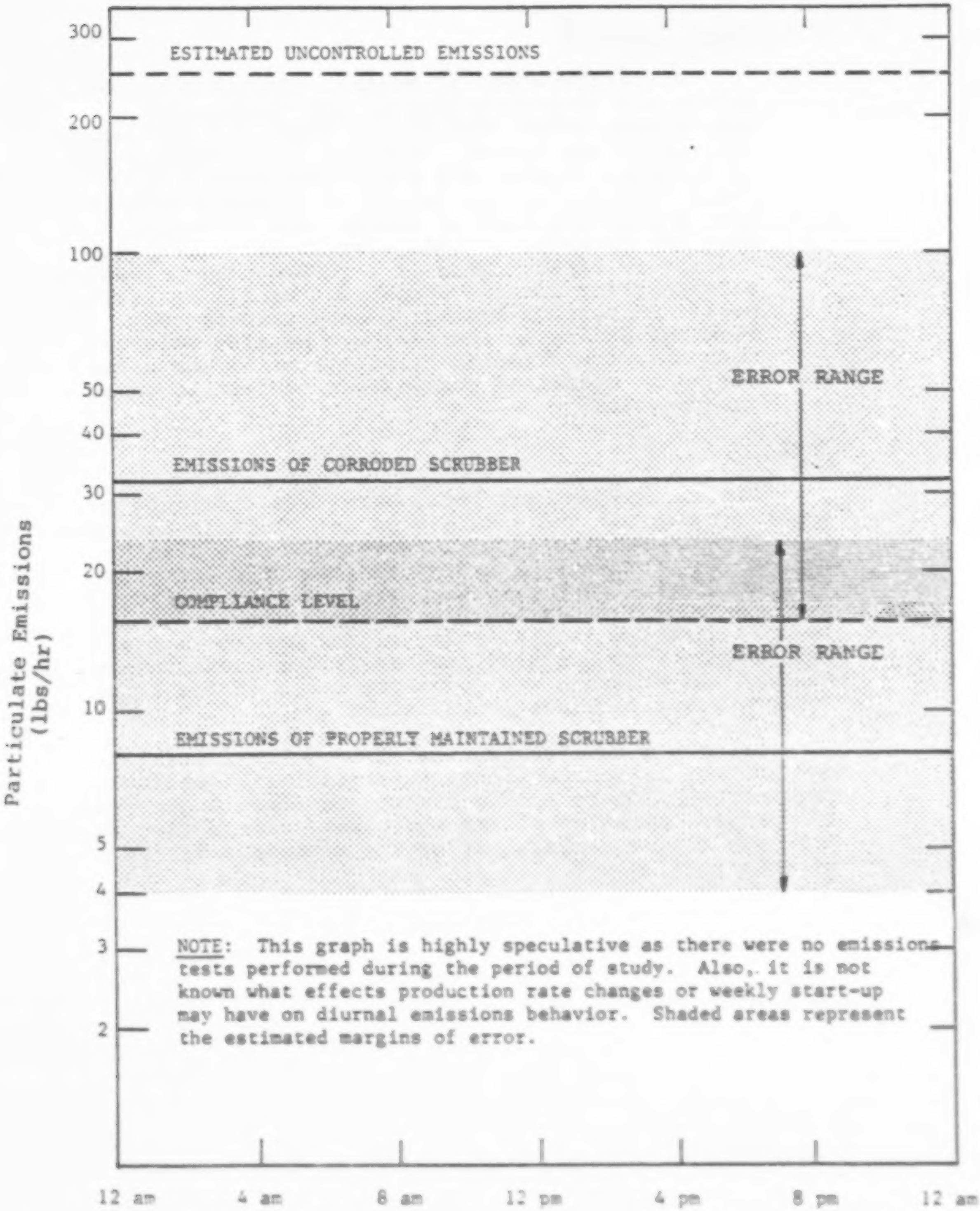
5.4 Spare Parts Inventory

The source maintains approximately $150 worth of spare parts for the scrubbers including nozzles and fan bearings. The source also keeps one spare fan for the plant which can serve the scrubbers as well as other equipment. The dollar value may appear small; nevertheless, it should be adequate for a simple system such as this.



NOTE: Solid line represents best estimate of particulate emissions. The estimated accuracy of this graph is ±200%.

Figure 1. Estimated Emissions Rate for Source 2.



NOTE: This graph is highly speculative as there were no emissions tests performed during the period of study. Also, it is not known what effects production rate changes or weekly start-up may have on diurnal emissions behavior. Shaded areas represent the estimated margins of error.

Figure 2. Estimated Diurnal Emissions Rate for Source 2.

5.5 Other Comments

While operation of control equipment is ultimately the responsibility of the source, the Agency must share some of the blame for the rapid failure of the system. Demands for recirculation of scrubber liquor were apparently made without fully considering the impact on scrubber materials. During the last 12 months, the inspectors have not bothered to take even crude pH readings using test paper. This is a fundamental procedure necessary for routine inspection of all wet scrubbers. Inspectors should do more than opacity readings during an inspection. We also believe that the recordkeeping stipulations of the permit should be exercised for sources subject to rapid deterioation.

6. Costs

Control system cost information was difficult to construct because the source does not maintain accounts specifically for the control equipment. The plant manager was not able to provide an accurate estimate of operating costs such as power usage, nozzle replacement, or annual labor devoted to the system. It was learned that the initial costs of the scrubbers was $11,000 (in 1977 dollars), not including installation. However, no estimate was given for costs of the major scrubber repairs since installation.

It should be stressed that the source installed the control devices strictly to satisfy air quality regulations. There are no present economic incentives for proper operation of the equipment, except that in the near future replacement of the equipment may be necessary.

INSPECTION REPORT

Source 3

1. Summary of Visit

This fertilizer plant was visited to inspect the emission control system for the rotary dryer and cooler operations. This control system consists of two cyclones and a five chamber shaker type fabric filter. Based on information obtained during the inspection and from State Agency files, it appears that the source has generally been in compliance since 1971, except for several months in 1976 when the original fabric filter system needed replacement due to wear. Plant management is genuinely concerned about emission and it, therefore, attempts to maintain the control equipment in working order. The Source has a good relationship with the Agency and does not attempt to disguise any emission problems or control equipment problems from the Agency. The source has been cooperative during routine inspection visits as well as during complaint investigations.

2. Chronology of Source/Agency Interaction

1970 - April. Agency visits Source to discuss control equipment plans.

1971 - November. Fabric filter added to plant. Initial compliance achieved.

1972 - January. Complaint received. Source reports equipment failure.

1973 - April. Routine visit by Agency. Source is in compliance.

1974 - September. Visit in response to complaint about ammonic fumes. Particulates in compliance.

- December. Routine visit by Agency. Plant down for the season.

1975 - February. Routine visit by Agency. Plant down for the season.

- June. Visit by Agency to evaluate other control equipment. Particulates in compliance. Permit issued.

- September. Routine visit by Agency. Plant down for the season.

- December. Routine visit by Agency. Plant in compliance.

1976 - February. Routine visit by Agency. Plant down for the season.

- April. Routine visit by Agency. Plant is not in compliance on particulates.

- June. Plant still out of compliance.

- July. Plant replaces worn out fabric filter system.

- November. Agency inspects new baghouses. Plant not operating.

1977 - January. Routine visit by Agency. Plant down for season.

- March. Routine visit by Agency. Plant in compliance.

- April. Permit revised to reflect new baghouses.

3. Plant Description

This source produces granulated ammonium phosphate fertilizer at a rate of up to 50 tons per hour. Production begins with the reaction of phosphate, sulfuric acid, and ammonia in a brick-lined reactor. The products of this reaction are introduced into an ammoniator-granulator where ammonium phosphate granules are formed. These granules are transferred into an oil-fired rotary dryer and then into a cooler. The cooled product is stored for transport.

The cooler-dryer unit produces particulates at a rate of up to 4,000 lbs/hr. The product is first dried in the rotary dryer and then transferred to the cooler. The cooler exhausts pass through a dry cyclone and are then recycled to the dryer. The dryer exhausts also pass through a dry cyclone and then through the fabric filters. All particulates collected from the cyclones and the fabric filters are recycled into the product stream.

The fabric filters consist of a five chamber, shaker type baghouse with draft induced by a 250 hp fan. The system has a total capacity of 28,000 scfm.

The filter system has approximately 1,000 12 ft. × 1 ft. diameter, filter bags supported by hook type shaker hangers. Bags are made of both dacron and cotton, as the Source has been testing the life of several materials. Bags are cleaned according to a shaker timer cycle, which causes one baghouse compartment to be cleaned every 12 minutes (i.e., each bag is cleaned once per hour). The dust hoppers are sloped at an angle of 60°, but they are not insulated or heat traced, and they have no vibrators. The five hoppers empty to a screw conveyor system, which traverses the entire baghouse. The screw conveyor is supported by wooden bearings.

4. Control Equipment Design Evaluation

The fabric filter system originally consisted of a unit similar to the present one except that it was approximately 20% smaller. This system provided reasonably good service for about seven years. By the end of its life, the original unit would not meet particulate regulations because of worn out shaker assemblies and inleakage through warped sidewalls. A larger device was chosen as a replacement because the Source wanted the control system to have a larger margin of safety.

The present 5 compartment system has sufficient capacity for compliance to be achieved with one compartment shut down. This capability reduces the number of plant shutdowns because of control system malfunctions. It was originally hoped that broken filter bags could be replaced while the plant was in operation. This proved impossible for the three interior compartments because of heat problems. The dryer outlet temperature is 200°F and the typical temperature at the filter inlet is 180°F. When an interior compartment is out of service the heat from the two adjacent units keeps its internal air temperature uncomfortably warm.

Bag life has not been exceptionally long. A typical bag has lasted 1½ to 2 years although the plant is in operation less than six months per year. Bags tear most frequently at the bottom near the hopper clamp, although tears have been found at many other locations as well.

The Source indicated that problems with the dust hoppers are infrequent. However, during the visit, it was noted that the lower 12 inches of each filter bag in one of the compartments was packed full of dirt, indicating that the hopper had recently been full. The plant manager said that such an occurrence was atypical and that it was probably due to a key employee's absence for a two week vacation. During this time the screw conveyor was not turned on as frequently as it should have been.

In general, the control system is well suited for the emissions of the dryer-cooler. It seems to provide excellent control and it is usually reliable.

5. Performance Evaluation

5.1 Preventive Maintenance

The fabric filter system requires a considerable amount of preventive maintenance to keep it operating properly. The system must be thoroughly checked each week before the plant is started up. In a typical weekly servicing, a two-man crew spends four hours at the baghouses checking bags, replacing torn bags, and performing other repairs that may be needed. In addition, a more thorough servicing is performed twice a year. At these times 40 to 50 manhours are required to clean bags. All bags are laundered or replaced once each year.

The Source takes special care to prevent condensation in the baghouses. During weekly startup, the source preheats the dryer and baghouses for up to two hours before wet fertilizer granules are introduced into the system. Production does not begin until baghouse temperatures reach 170°F. The Source also leaves the fan on after weekly dryer shutdowns to properly cool and dry the baghouses. These precautions have prevented fabric blinding and corrosion problems.

5.2 Recordkeeping

No data is maintained for the fabric filter system other than the purchase orders for spare parts and bag laundering services. The temperature gauges and differential manometers are checked at least once per shift but the values are not recorded. It is doubtful that extensive recordkeeping would improve the already good performance of the control equipment. However, the Agency should require that a simple log book be maintained to record the hours that the equipment is operating; the dates, durations, and causes for any equipment malfunctions; and periodic manometer measurements.

5.3 Emissions

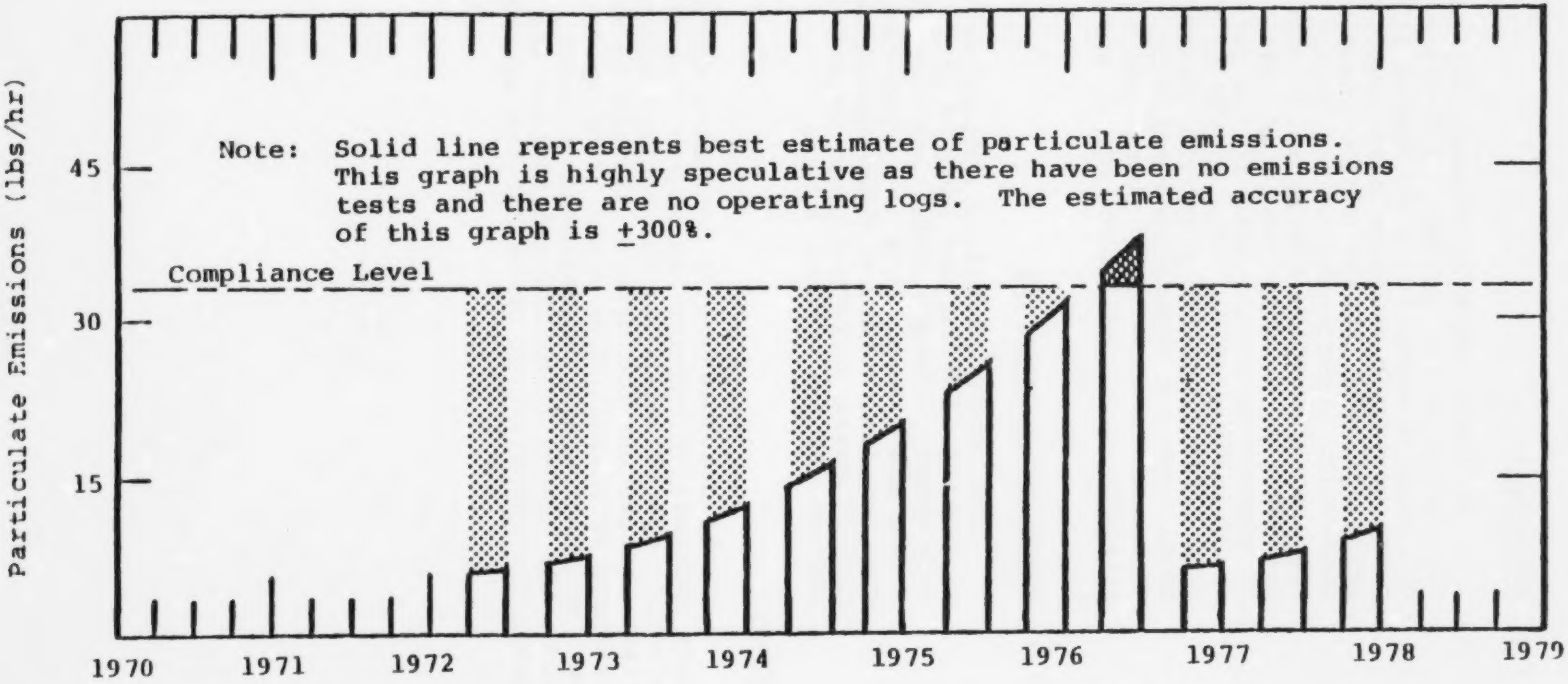
No stack tests have ever been conducted on the fabric filter system. The State Agency does not require stack tests on fabric filters unless there is strong evidence that compliance is not being achieved. Based on the State's visual inspection reports and on the Source's practice of stopping production during major control system failures, it must be concluded that the Source was in compliance during most of the period of this study (1970 - 1977). The spring of 1976 was the only period when the plant was probably not in compliance. A generalized estimate of annual emissions is shown in Figure 1 and a generalized estimate of diurnal emissions is shown in Figure 2.

5.4 Spare Parts Inventory

The Source maintains a spare parts inventory consisting of about 600 bags (4 to 5 breaks occur each week), 3 hanger rods, and 100 bag hooks. The Source also keeps spare fan motor bearings, but it does not feel a need to keep shaker bearings. The lack of spare parts has never caused a major problem for the control system.

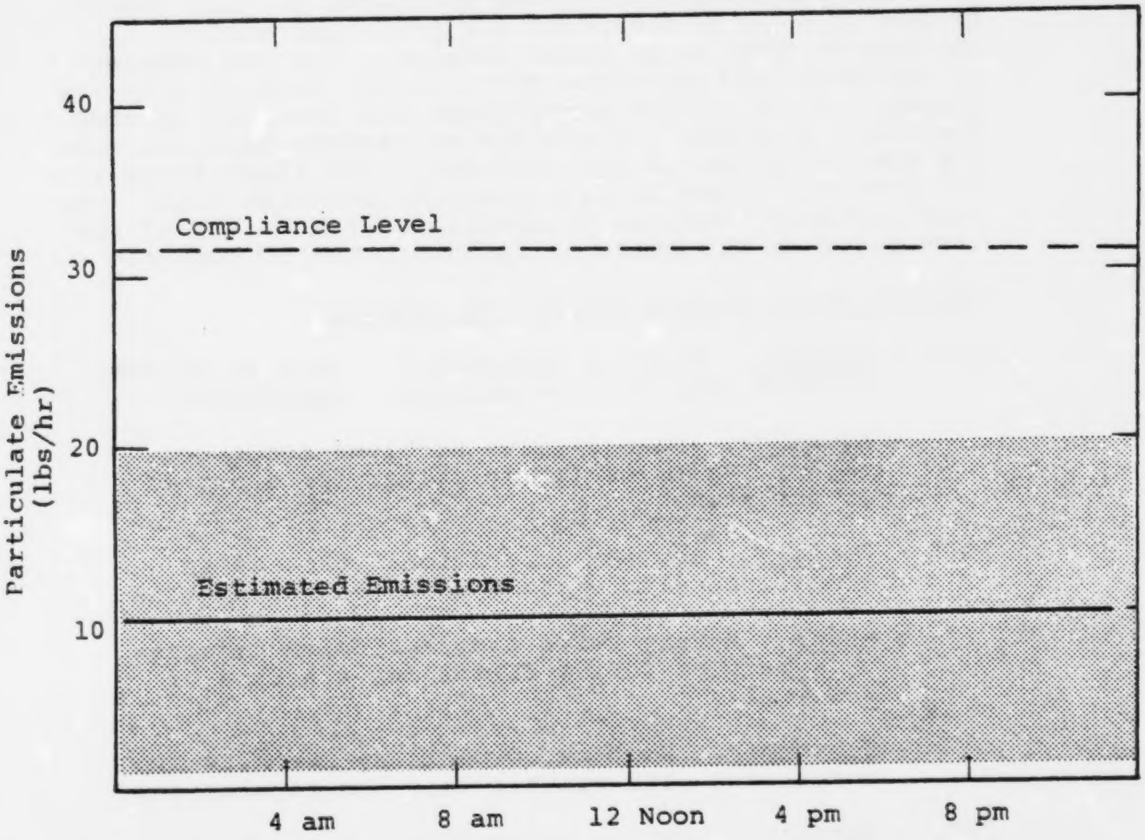
6. Costs

It was not possible to construct control system cost information because the Source does not maintain accounts specifically for the control equipment. The Plant Manager was not able to provide an accurate estimate of installation costs or of operating costs such as power usage and maintenance labor. In addition, the Agency files did not contain any information about the installation costs for the system.



Note: Solid line represents best estimate of particulate emissions. This graph is highly speculative as there have been no emissions tests and there are no operating logs. The estimated accuracy of this graph is ±300%.

Figure 1. Estimated Particulate Emissions Rate for Source 3.



NOTE: Shaded area represents the error range of the emissions estimate. This graph is highly speculative as there have been no emissions tests performed and there are no operating records.

Figure 2. Estimated Diurnal Emissions Rate for Source 3.

INSPECTION REPORT

Source 4

1. Summary of Inspection

The fabric filter system evaluated in this report is one of a large number of air pollution control devices at this large plant complex. The underdesign of the unit (air-to-cloth ratio of 20) coupled with the stickly nature of the particulate has resulted in some operating problems. There are no records kept concerning the operation of the equipment, and stack tests are not possible since it is a positive pressure unit. The unit probably operates in compliance 90% to 95% of the time based on the reported failure rates of components.

2. Chronology of Source/Agency Interaction

1974 - October. Routine inspection; unit is in compliance with visible emission regulations.

- November. Rotary valve problems force temporary bypass of fabric filter for a period of one week.

1975 - January. Routine inspection; unit is in compliance with visible emission regulations.

- March. Rotary valve problems force temporaty bypass of fabric filter for a period of one week.

- September. Routine inspection; unit is in compliance with visible emission regulations.

1976 - January. Routine inspection; unit is in compliance with visible emission regulations.

- January. Company requests renewal of operating permit.

- February. Routine inspection; unit is in compliance with visible emission regulations.

- March. Permit approved by the State.

- August. Routine inspection; unit is in compliance with visible emission regulations.

- December. Routine inspection; unit is in compliance with visible emission regulations.

1977 - March. Routine inspection; unit is in compliance with visible emission limitations.

- May. Routine inspection; unit is in compliance with visible emission limitations.

3. Plant Description

The plant obtains woodwaste from other local plants belonging to the company that are involved in various phases of furniture production. The plant converts these wastes into a pressed board product. Usable chips are pressed and bonded together to form chipboard to which a veneer material is applied; hence, the term chipcore. A diagram of the process is included.

The baghouse is a Carter-Day design handling 33,600 acfm of exhaust gas from the hood around the abrasive planers. Particulate matter from the abrasive planers range from very fine sawdust to very long, stringy chips. This matter contains adhesive used to bind the chipboard as well as abrasive particles from the planers. This material is highly susceptible to bridging and agglomeration.

The gas entering the baghouse is pre-cleaned by a large cyclone with 75° cone angle. The baghouse contains 144 84-inch Dacron^R polyester bags. Bag cleaning is achieved using a reverse air pulse and each bag is cleaned once every minute. A rotary arm equipped with dampers and the reverse air from a continuously operating fan passes over the bags. The bags are arranged on radial lines, 4 deep, with a cam located in close proximity to the bag on the upper tube sheet. As the rotating arm passes over the bag the cam opens the damper in the arm and allows the reverse air pulse to enter the bag.

The discharge from both the cyclone and the baghouse are supplied with a 4-vaned, flexible tip rotary discharge valve. These are necessary because of the pressure differential between the control equipment and the duct used for conveying the captured material to a dust bin (this captured material is used as fuel for one of the plant's boilers). The State's files indicated that the rotary discharge valves are a major source of problems. If these valves are not functioning properly, the material will agglomerate and bridge in the cone forcing the bypassing of the control equipment or shut down of the process equipment. Other problems encountered include bag fires, condensation and freezing of moisture during cold weather, and a variety of equipment failures.

The agency files did not list any complaints against the plant. The agency is called when the units malfunction and are advised of the problem and the expected duration of emissions until the problem is corrected. There were no records of these phone conversations in the agency files. The rotary valve problems were noted in the routine quarterly inspection reports.

4. Control Equipment Design Evaluation

The baghouse is approximately 8 feet in diameter with 36 rows of 4 bags each mounted radially from the center of the baghouse and provides 3,680 ft^2 of filter area. The gas enters the bottom of the baghouse tangentially, around a baffle (wear) plate and passes through the bags. As previously mentioned, the bags are cleaned by a reverse air pulse supplied by a rotating arm. The reverse air is supplied by a continuously operating 3,600 rpm, 25 hp fan mounted on top of the unit. The air used for the reverse pulse is taken from the clean air side of the bags.

The baghouse and cyclone units are located outside the plant immediately adjacent to the building. Access to the top of the baghouse is achieved by climbing a caged ladder approximately 25 feet above ground level. At this level personnel have access to the reverse air fan, rotating arm, gear box and motor, and the top of the bags. The bottom of the bags are accessible through a door on the discharge cone located about 10 feet off the ground. The personnel at the bottom of the bags must stand on rails 3 - 4 inches wide suspended across the cone. Access to the top of the pre-cleaning cyclone is achieved at the roof level.

The instrumentation for the baghouse is simply a 0 - 10" H_2O magnehelic gauge. This has been placed at ground level so that personnel may read the pressure drop without climbing up the ladder. Copper lines are used to connect the pressure taps thus avoiding the problems of deterioration normally associated with plastic lines.

Clearly, some of the problems encountered by the plant are due to the nature of the particulate. The combination of very fine particulate and adhesive makes this a very difficult material to clean from the bags. Furthermore, over a period of six months the sawdust "seeps" through the bags to a point where the bags are difficult to clean and pressure drops are excessively high. Overloading of some of the other baghouses at the plant has occurred because of undersizing (A/C of 20). This has necessitated the purchase of additional equipment to bring the air/cloth ratio (face velocity) back to 10 - 12 ft/min. The problem of bleed-through could probably be reduced by reducing the current A/C ratio from 12.5 to 6 - 8 ft/min thereby extending bag life. However, the Company representative indicated that while this could be possible there are no plans to do this and most units are designed with an A/C ratio of approximately 10 ft/min.

A particularly interesting aspect of the design was the vendor's use of air from the clean side of the bags to supply the pulse used in cleaning the bags. It is our opinion that ambient air (with an appropriate filter) would be a better alternative. As the cleaning action of the bags deteriorates, they allow more and more dust to pass through. This in turn is picked up by the reverse-air pulse fan and the dust is injected into the clean side of the bag during the pulse, accelerating bag deterioration. The use of ambient air has been considered and may yet be used according to the Company representative.

Finding a leaking bag in this system is, at best, difficult. The use of fluorescent materials and a blacklight may aid in determining which bag is leaking. However, because of the aforementioned problems with the cleaning system, enough damage may have already been done to require replacement of all the bags.

Another problem encountered is the generation of sparks at the abrasive planer. Several times the bags have burned very rapidly without setting off the sprinkler system. A light detector has been placed in the hood and connected to a system to close the dampers in the event a spark is generated. Some doubt was expressed by the plant representative concerning the reliability of the system.

The problem of material bridging has been mentioned previously. When this occurs it typically requires 4 men to "dig" the material out. This problem is further compounded during cold weather when moisture from inside the building condenses and/or freezes inside the control equipment. Because the plant operates only 16 hours a day, 5 days/week, the fans to the control equipment are shut down overnight and on the weekends as an energy conservation measure. However, unless fans are turned on several hours before the plant shift begins and the control equipment allowed to warm up to thaw any existing ice, several hours of production are lost due to condensation problems. Any constriction may further promote the bridging of the captured material. The unit inspected is not insulated.

5. Performance Evaluation

5.1 Preventive Maintenance

According to the Company representative, 2 to 3 hours/week preventive maintenance should ideally be performed. In reality, this is not the case and the control equipment seems to be looked after only when there is a problem. The plant manager of each plant is supposed to check the equipment daily for proper operation and signs of impending trouble. Apparently, such is not the case in many situations.

The maintenance department is responsible for a large number of control units as well as process equipment. There is a feeling that the baghouses are not really necessary and therefore, process equipment has higher priority than control equipment in terms of maintenance. Furthermore, the maintenance department is probably understaffed when compared to the great number of plants and pieces of equipment to attend to. Thus, maintenance on the fabric filters is generally done on a "as needed" basis rather than on a regular preventive maintenance schedule.

5.2 Recordkeeping

Some records are kept concerning pressure drop and operation of the control system (rotary valves, fans, etc.). However, this recordkeeping is not consistent from plant to plant. There are examples within the Company where records are routinely taken and control equipment is checked at least once a day. In these instances there have been few unexpected malfunctions. The major point emphasized was that the data taken must be analyzed to determine the condition of the equipment. Recordkeeping alone will not prevent maintenance problems.

5.3 Emissions

Since stack test data and useful performance data is not available, it is difficult to prepare a meaningful emission profile. The quantity of excess emissions occurring during malfunctions is a complex function of the emission characteristics and the type of malfunction. The unit, as designed, would be impossible to stack test using Method 5 and criteria established under Method 1. Some form of stack extension would have to be constructed. Based on the Company experience with a number of fabric filters similar to the one inspected, certain routine operating problems can be expected. These are summarized below.

Expected failure rate:

Rotary value bearings - 2 to 4 times/yr

Bag breakage or bleed-through - requires bag change every 6 months

Damper tensioning springs on cleaning drum - 3 to 4 times/yr

Cleaning head (rotating arm) - some have never failed, others have failed 2 - 3 times since installation. The system inspected has suffered no failures since installation.

Based on the reported rates of component failure, our internal inspection of the equipment, and the comments of the source representative, we estimate that excessive emissions occur 2 to 5% of the operating time. This is illustrated on the emissions profile in Figure 1. Such nonoptimal performance is most common in the winter months. The maximum duration of excess emissions is probably 12 to 16 hours. While more intensive maintenance may reduce total energy consumption, we do not believe that it will significantly reduce the levels of excess emissions.

5.4 Spare Parts Inventory

Approximately $6,000 of spare parts are kept on hand for maintenance purposes. Included in this inventory are:

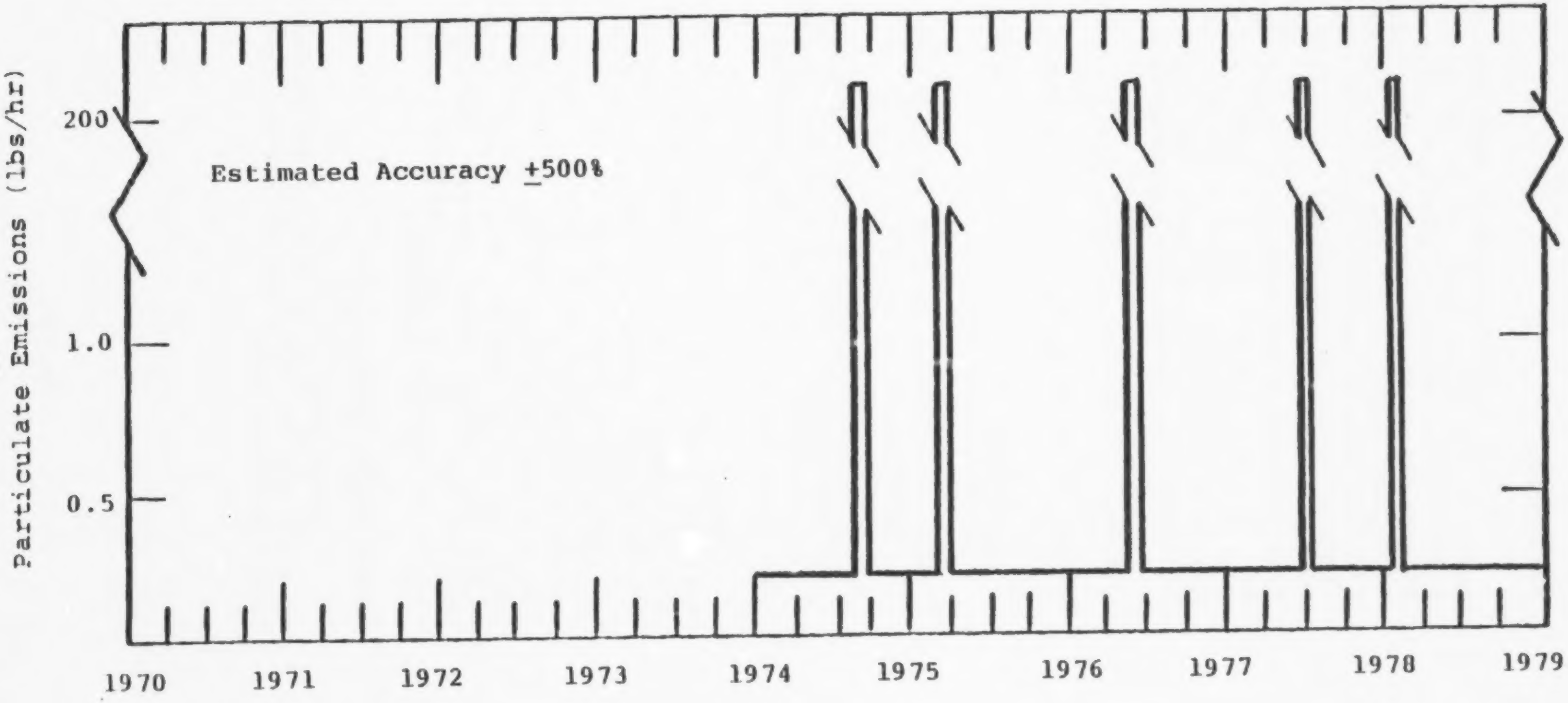


Figure 1. Estimated Annual Particulate Emissions Rate for Source 4.

Item	Number	Approximate Cost Each
Reducing gearbox for cleaning head	4	unknown
84 inch Dacron polyester bags	144	$ 7.50
Spare cages	144	$ 20.00
Small 1 and 2 hp motors	4	unknown
Blower motor (3,600 rpm)	1	unknown
Cleaning arm & mechanisms	1	unknown
Bearings for rotary discharge	12	unknown
Tension springs for cleaning arm dampers	48	unknown

Delivery time can be from 1 to 2 days on standard motors to 3 to 4 weeks for non-standard motors and for bags. The lack of spare parts has never caused or aggrevated an excess emissions incident for this unit.

6. Costs

The total installed costs of the system 1 baghouse was estimated at 485,000 (1978 dollars). However, we suspect that other baghouse units may have been included in the cost figure. Overall, the Company has reported air pollution control related capital costs of $8,000,000 for all systems combined.

Annual operating costs include $60,000/yr for electrical power, 3 men full-time, 1 truck and lost production. A total dollar value was not given and the above figures are for the Company's wide air pollution control and maintenance program.

INSPECTION REPORT

Source Number 5

1. Summary of Inspection

The Company has installed an electrostatic precipitator on a 30 year old pulverized coal-fired boiler now used solely for peaking service. Due probably to economic considerations, the precipitator was marginally designed, therefore, nonoptimal conditions result in noncompliance. The precipitator has probably been operating out of compliance approximately 50% of the operating hours during the last two years. The inspector has failed to discover some possible violations due to his reliance on opacity as an indicator of excess emissions. In this particular case, the mass emissions can reportedly be substantial while opacity levels are below State regulation limits.

2. Chronology of Source/Agency Interaction

1972 - June. Source applies for temporary operation permit.

- August. Agency grants temporary permit.

- December. Source applies for construction and operation permit on Unit 1.

1973 - January. Source applies for construction and operation permit on Unit 2.

- March. Permit granted on Unit 1 by Agency.

- April. Permit granted on Unit 2 by Agency.

1974 - April. Source applies for permit renewal on Unit 1.

- May. Agency grants permit renewal. Unit 2 to be operational by March 1975.

- December. Apparent initial compliance with mass emissions regulations.

1975 - January. Both units stack tested, in compliance with mass emission limitations.

- March. Routine inspection; Units 1 & 2 operating. No visible emissions.

- May. Routine inspection; no visible emissions.
- October. Malfunction reported to Agency. Economizer leakage caused malfunction on Unit 1. Particulate matter build-up on plates and opacity greater than 40%. Increased rapping would be initiated.
- December. Source reports precipitator malfunction. Unit will operate for two days until shut-down for repair.

1976 - March. Source notifies Agency of precipitator malfunctions (both units). Will be corrected within 10 days.

- July. Source applies for permit renewal on Unit 1.
- October. Routine inspection; both units in violation of visible emission limitations. Dust build-up on plates reported. Units scheduled for washdown.
- December. Routine inspection; both units in violation of visible emission limitations. Permit renewal on Unit 1. Stack test required.

1977 - January. Follow-up inspection; units washed down. Wash-down did not help Unit 1 and it is in need of repair.

- March. Stack test conducted and unit found to be in compliance with mass-emission limitations.
- March. Routine inspection; boilers not operating.
- May. Source applies for permit renewal on Unit 2.
- July. Routine inspection and permit review. Both units operating at 100% opacity and out of compliance.
- August. Follow-up inspection; Unit 1 operating with one section out, 5% opacity. Unit 2 operating out of compliance (80%-100% opacity) with low power levels, warped plates, and broken wires reported to be the cause.

- December. Permit renewed for Unit 2. Stack test required by April 1978.

1978 - January. Source reports problems with Unit 1; one panel out and power levels low.

- March. Stack test postponed to clear up operational problems.

- June. Routine inspection; Unit 1 in violation with one panel out and power levels low. Unit 2 to be washed prior to stack test.

- July. Stack test of Unit 1; in compliance with mass-emission limitations.

3. Plant Description

The source generates electrical power from 4 pulverized coal-fired boilers. Two of the older units are in cold reserve. These units are not of concern in this report. The other two units are boilers now serving as "peaking" units. Rated power capacities each is less than 200 and greater than 150 MW. Gas flow rates for these units are in the range of 450,000 to 600,000 acfm. at full load. The boilers are 30 years old. It was more economical to utilize the units for peaking operations than to retire them from service and build another facility.

The power plant is located in an industrial park in a rural area of the State. There are less than 50 residences within a 3-mile radius of the plant. Effluent is discharged from two 300 feet high stacks.

4. Control Equipment Design Evaluation

The Company employed a consulting firm to specify the necessary parameters for the design of the precipitators. Supposedly the age of the boilers was not considered in the design of the precipitators.

Both units are similar in design but have a different number of electrical fields. Unit 1 utilizes five fields in-series whereas Unit 2 has six. Each was designed based on coal with 0.7% sulfur. Unit 1 requires eight hoppers for ash removal and Unit 2 requires 12 hoppers. Hopper discharge is accomplished by pneumatic conveying.

The units are well-insulated. There has been no evidence of corrosion due to gas temperatures below the acid dewpoint. Gas temperatures are typically 275°F and may be as low as 240°F in winter. There has been some superficial flaking from the plates which occurs after periodic washdowns. However, this flaking is not considered to be serious.

Based on the limited data available, it is our opinion that these units are underdesigned. The specific collection area (ft^2 per 1000 acfm) is approximately 350. This is considerably less than now considered necessary to achieve compliance with particulate emission regulations when burning low sulfur coals. Figure 1 presents a comparison of the design SCA and our estimate of the necessary SCA.

It should be noted that the information presented in Figure 1 was just beginning to emerge in technical literature at the time this precipitator was designed. With the benefit of hindsight, it is apparent that the units are undersized; however, this data was not available in convenient form for review by either the Agency or the source. The vendor was apparently aware of the problem since it refused to guarantee precipitator performance. We conclude that the source acted in good faith to comply with emission regulations; however, the economics of peaking boilers dictated the lowest possible cost thus the lowest possible margin of compliance.

5. Control Equipment Performance Evaluation

There are several recurring problems experienced by the source. The most common problem appears to be broken wires (averaging approximately one/month). The cause of the wire breakage is presently unknown. It is possible that the cyclic nature of the boiler operation is fatiguing the wires and gradually causing failure throughout the precipitators.

There have been various hopper problems. Some of the hopper plugging has occurred because the discharge wire bottle weights have fallen into the hopper blocking the hopper exit. The hoppers are also occasionally plugged by flyash bridging. Apparently the hopper heaters do not always prevent moisture from causing bridging. Level indicators have been installed approximately two-thirds the way up the hopper side. The units are capacitance types and are connected to alarms in the control room. There is approximately 2 to 3 hours between the time the level indicators activate the alarm and the time the hopper is full. However, the level indicators are not always reliable and there have been occasions when hopper pluggage has gone undetected. Hoppers are normally emptied twice per shift.

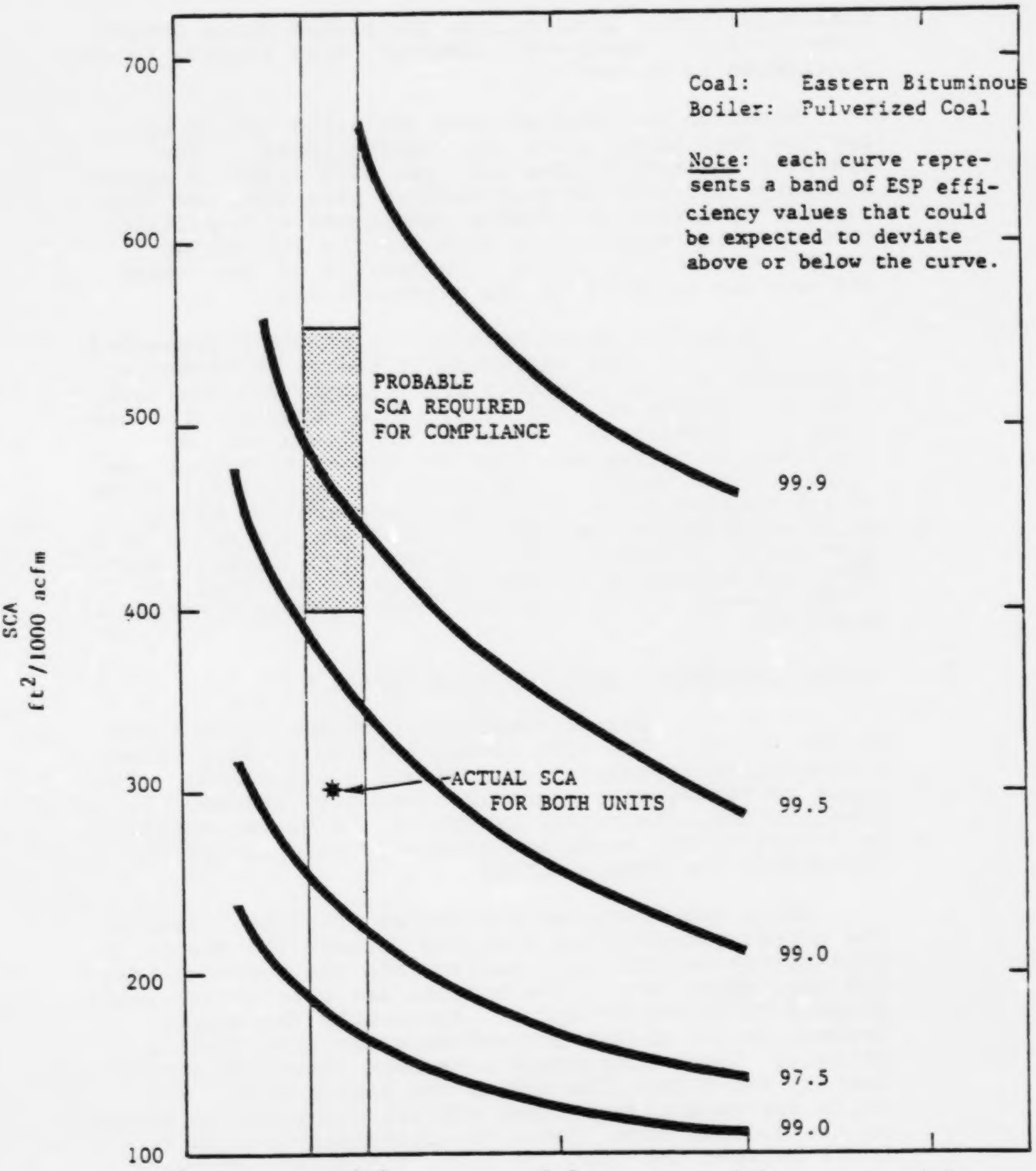


Figure 1. SCA Requirements Versus Sulfur Content: Cold-Side ESP, Pulverized Eastern Bituminous.

There is a gradual build-up of particulate matter on the plates which requires a periodic wash-down of the units. This gradual build-up typically results in the degradation of precipitator performance. When the build-up occurs, the units are scheduled for a wash-down during the next outage. We speculate that this problem could be due either to high resistivity flyash or low intensity rapping. While we were not permitted to perform an internal inspection, the observations we were able to make from the access hatches suggest to us that hopper operation is not the major problem. High resistivity is the most probable cause of the problem considering the use of low sulfur coals, low power density conditions and particulate build-up on the plates. We recommend that an in-situ resistivity test be performed to confirm this condition.

A problem not noted in the Agency files but brought to our attention during the visit was the necessity of replacing the precipitator roofs. This problem has not been an isolated incident at this plant. All of the utilities precipitators manufactured by this vendor have required replacement of the roofs at other company facilities. Roof replacement was necessary because of leaks and standing water which provided corrosion sites. The problem apparently has been solved.

The vendor did not provide the source with operating instructions, optimization procedures, troubleshooting guides, or recommended preventive maintenance schedules. Consequently, the source has been required to use past experience to develop operation and maintenance procedures. For example, rapper optimization has been attempted in a trial-and-error manner. On one precipitator only rapper intensity may be varied since rapper sequencing is controlled by a "random number generator." This has required operation of some rappers at full intensity for long periods of time while attempting to establish optimum conditions. (There has been no apparent damage from full intensity rapping.) Furthermore, some rapping control card failures have occurred without the source becoming aware of the problem. Attempts to optimize performance without guidance from the vendor may hamper efforts to operate the equipment properly on a day-by-day basis.

5.1 Preventive Maintenance

The source is presently developing preventive maintenance procedures. Procedures currently employed are:

1. Check of rappers and TR set readings are made daily by operators.

2. Hopper heaters are checked daily for proper operation.

3. Hoppers are emptied twice per shift. Hoppers have enough holding capacity to be emptied only once per shift. However, emptying twice per shift minimizes the risk of ash build-up and plate warpage.

The vendor has not provided recommended annual maintenance procedures. It should be noted that during the annual outage the discharge wires which have been cut out during the year are not replaced.

The preventive maintenance procedures appear adequate particularly considering the frequent occasions for internal repair possible with a peaking boiler.

5.2 Recordkeeping and Monitoring

The source is currently installing transmissometers on the outlet of each precipitator. The display/recorder is being installed in the control room with the other indicators and alarms associated with the operation of the control equipment.

The source maintains records of TR set readings, hopper levels, and frequency of hopper emptying. TR set readings include primary voltage, primary current, and secondary current. Spark rate is not monitored. Daily boiler operation logs which include boiler load are kept at the Company's headquarters office. These records were not available for our inspection.

Maintenance records are available in the form of work orders and weekly maintenance summaries. The work orders were not available for our inspection. A weekly summary report provides a limited amount of information concerning the type of work done and the conditions found inside the equipment. For example, the summary may specify that several broken wires were cut out but the location is not recorded.

Information such as broken wire location should be recorded in a fashion that is easily retrieved, e.g., a maintenance log. It is also recommended that results of air load tests be recorded in a maintenance log.

5.3 Emissions

The source's operating permits specify that an emissions test will be performed within 90 days of initial operation and permit renewal. The State has not required strict adherence to this. However, both precipitators have been tested twice (Method 5) and will be required to be tested once every three years for permit renewal.

Both precipitators have passed all of the stack tests. The emission rate for Unit 1 has been 0.016 and 0.28 lb/10^6 Btu during each test at full load (allowable rate is 0.16 lb/10^6 Btu). The results of the most recent test on Unit 2 were unavailable but the first test indicated an emission rate of 0.016 lb/10^6 Btu. These results appear to be very low considering the design problem already discussed. The results of the stack test appear to indicate that the equipment is operating extremely efficient. It must be noted that the State allows the source to schedule the stack tests. Several stack tests have apparently been cancelled because the source was unable to achieve maximum control equipment performance prior to the stack test. In our opinion, the Method 5 test results are not indicative of normal emissions.

At issue is the "representativeness" of the stack test results to the normal operation of the equipment by the source. In discussions with the source personnel it was revealed that emissions may be excessive as much as 50% of the time. However, the source can remain in compliance with limitations between 85% and 90% of the time. According to the source, when a plume is visible (i.e., 10% - 20% opacity) it is likely that the source is out of compliance with mass-emission limitations. The inspector erroneously believes that a greater than 40% opacity is necessary to indicate non-compliance, thus, the source has been inadvertently allowed to operate in non-compliance for extended periods of time.

The annual average emissions profile (Figure 2) is subject to substantial error because examination of some records was not possible, the representativeness of stack test is doubtful, and little useful data exists. The values shown in Figure 2 are based on a correlation between opacity and mass-emissions. The correlation used to develop Figure 2 is shown in Figure 3. This correlation, developed by Conner* from short-term transmissometer data for a pulverized coal-fired power plant, is presented only as a guide and should not be construed to accurately represent the actual long-term emissions of the plant that is the subject of this report. A number of assumptions have been made in the use of Figure 3 to develop the emissions profile in Figure 2. The assumptions include, but are not limited to, 1) the opacity readings, when given, are correct, 2) there exists a close correlation between observed opacity and opacity that would be seen by a transmissometer, 3) when the inspector's report states that the source was out of compliance the opacity was 40% - 50%, 4) boiler load was near rated capacity during observations allowing conversion from concentration to lb/106 Btu, and 5) at 10% opacity this plant is emitting 0.16 lbs/MMBTU. By making these assumptions an attempt to construct the emissions profile in Figure 2 could be made. The emissions profile reflects general comments of the plant personnel that the emissions exceed compliance requirements at least 50% of the operating hours. The shaded area represents an estimate of the possible error in these emissions calculations.

There is no data whatsoever to prepare a diurnal emissions profile. Actual emissions will be a function of load conditions which are highly variable.

These excess emissions are probably inevitable due to the undersized precipitators. Options for achieving compliance may include: 1) use of higher sulfur coal, 2) use of flyash conditioning, and 3) adding additional collection plate area. There is some question whether the latter two options could be justified on economic grounds considering the age of the boilers. The first option results in greater SO_2 emissions. Perhaps the State should consider issuing a variance to this source contingent upon a highly specific maintenance plan and prompt repair of any malfunctions.

Prevention of excess emissions could probably

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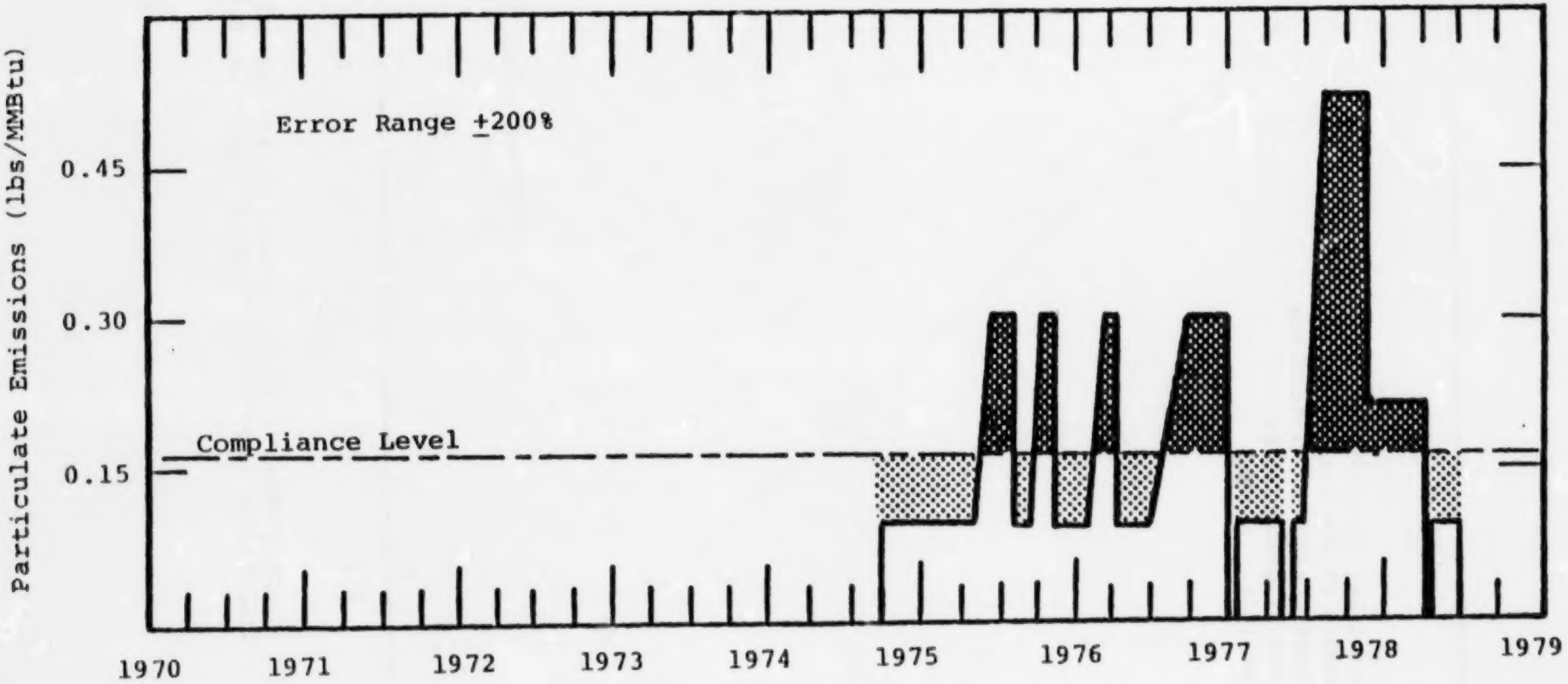


Figure 2. Estimated Emissions Rate for Source 5.

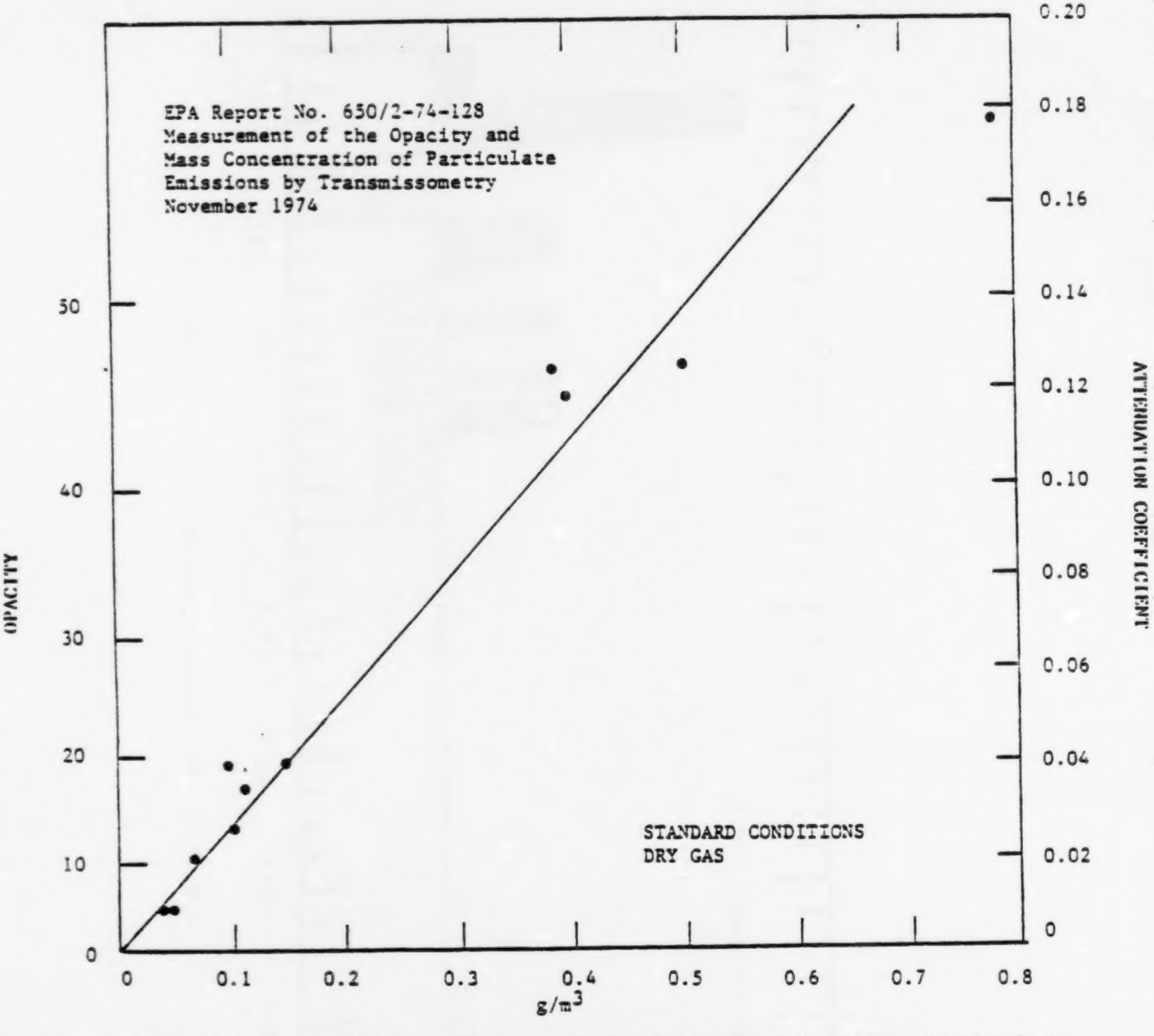


Figure 3. Opacity-mass Concentration Relationship for Particulate Emissions from a Bituminous Coal-fired Boiler.

have been effectively done in the design stage. Exercising the provisions included in the operation permit, such as recordkeeping and operation/maintenance plans, would probably reduce emissions 20% or less.

5.4 Spare Parts Inventory

The vendor did provide a recommended list of spare parts. The source has in its spare parts inventory circuit breakers, coils, relays, weights, discharge wires, insulators, and 2-3 rapper sequence control cards (control cards cost ~$500 each). No overall value was given for the spare parts inventory kept by the source. Furthermore, parts and service are readily available from other locations in the Company's network as well as from the vendor. There is no reason to suspect that any period of excess emissions has occurred because of a part being unavailable.

6. Costs

Cost data was unavailable (except initial estimated purchase costs). The estimated purchase costs of the unit was $2.1 million, (and were presented in permit application). Total parts and labor costs for maintenance have not been tabulated. From maintenance summaries only 100 to 150 hours labor/yr per precipitator could be accounted for. This estimate seems low but may be more correct than suspected since the units are operated only 2000 to 3000 hours per year.

INSPECTION REPORT

Source 6

1. Summary of Visit

An electrostatic precipitator controlling emissions from a kraft pulp mill recovery boiler was inspected. The source has made a conscientious effort to reduce the emissions of sulfur compounds and particulate matter normally associated with kraft pulping operations. Reduction of these emissions has been accomplished by process modifications and installation of more efficient control equipment. The subject of this report is the performance of the electrostatic precipitator controlling particulare emission from a new "low-odor" recovery boiler. This recovery boiler was constructed to replace several smaller, less efficient boilers and increase plant capacity. The source provided data indicating that the source generally operates in compliance with mass-emissions limitations and normally has a substantial margin between allowable and actual emissions. However, the source has encountered some problems with exceeding opacity limitations although in compliance with mass-emissions limitations.

2. Chronology of Source/Agency Interaction

The Company has numerous sources located at the plant, many of which are covered by separate operating permits. To simplify matters, only the major areas of concern will be presented in the chronology.

1970 - November. Source applies for temporary permit to operate air pollutant sources.

1971 - February. Agency grants temporary permit to Source.

1972 - December. Source applies for new temporary permit to operate air pollutant sources. Previous permit expired.

1973 - February. Source applies for construction of new low-odor recovery boiler and ESP to control particulate emissions. Agency grants permit.

- March. Agency grants temporary permit to Source. Source must develop plan of action to bring plant into compliance with state regulations.

1974 - March. Source applies for permit to construct and operate venturi scrubber on lime kiln. Two other kilns already controlled by scrubber.

- April. Agency grants permit for scrubber.

1975 - July. Source applies for permit for modification of one existing recovery boiler, addition of new ESP's for existing recovery boiler, construction and operating of new lime kiln controlled with a venturi scrubber; other miscellaneous equipment included.

- August. Routine inspection; existing lime kiln with new scrubber operating and in compliance with opacity limitations.

- September. Compliance evaluation; existing boilers out of compliance with odor and opacity regulations.

- October. Agency grants permit for recovery boiler modification and new lime kiln.

1976 - December. Source applies for permit renewal for new recovery boiler.

1977 - February. Compliance evaluation; new lime kiln controlled and appears in compliance with opacity limitations. All other sources appear in compliance.

- April. Agency grants permit renewal for new recovery boiler.

- May. Routine inspection; modified recovery boiler modifications completed and in compliance with opacity limitations; assumed to be in compliance with mass emissions regulations for the first time.

- August. Routine inspection; modified recovery boiler experiencing problems with odor control system. All other sources in compliance with opacity limitations.

1978 - February. Routine inspection; all sources appear in compliance with opacity limitations.

- June. Routine inspection; all sources appear in compliance with opacity limitations.

3. Plant Description

The unit that is the subject of this inspection was an electrostatic precipitator controlling particulate emissions from a new "low-odor" design recovery boiler. The precipitator is a rigid frame discharge electrode ESP tile-lined dry bottom.

The primary purposes of a recovery boiler are to recover the heating value of the hydrocarbons in the black liquor and to recover Na_2CO_3 and Na_2S. The par-ticulate matter generated by the recovery boiler may be Na_2CO_3, Na_2SO_4, or both and possibly small amounts of Na_2S. This particulate matter is captured by the ESPs and is recycled back into the black liquor for combus-tion. The recovery of Na_2CO_3 and Na_2S from the boiler occurs as a smelt from the bottom of the boiler where it is dissolved to form "green liquor". There is an incentive (both economical and regulatory) to recover and recycle these materials.

There is another recovery boiler at this plant which has been modified to reduce sulfur emissions. The plant operating load determines the recovery boiler loads. The plant management has a certain degree of freedom to balance the distribution of boiler loads to accomodate any situation that may arise. The new recovery boiler has a capacity of 4,500,000 lb of dry solids/day.

4. Control Equipment Design Evaluation

The ESP controlling particulate emission from the new recovery boiler is a rigid frame discharge electrode design rather than the more familiar weighted-wire system. The electrostatic precipitator contains 253,170 ft^2 of plate surface area (corrugated plates 45 ft. high, 15 ft. wide) and was designed to perform at 99.6% removal efficiency. The nominal gas volume is 535,000 acfm at 395°F. Calculations reveal an SCA (specific collector area) of approximately 475 ft^2/1000 cfm which is somewhat higher than we have encountered previously. It should also be noted that the gas velocity through the precipitator (2.4 ft/sec.) is lower than the 3-4 ft/sec normally encountered. In considering the higher than normal SCA and the lower gas velocity through the precipitator, we feel that the source has demonstrated an effort to not only meet the standard but to exceed the required design efficiency by "overdesigning" the control equipment.

The gas flow into the precipitator is split to enter the precipitator's two parallel chambers. Each chamber contains 3 fields in-series. The number of in-series fields is lower than encountered elsewhere, where 4 and 5 fields in-series have been common. However, in view of the design parameters mentioned above the number of fields is reasonable. The TR-sets incorporate automatic spark limiting which cannot be controlled by plant personnel. Each chamber can be isolated by means of slide gate dampers and the inlet and outlet of the ESP. This allows any necessary maintenance work to be performed with at least half of the precipitator operating with all gas flow passing through one chamber of the precipitator.

In the event that a precipitator malfunction occurs there are a number of options which are available to the plant management personnel. For example, if a discharge wire broke and short-circuited a TR-set it would "trip-out" the TR-set and set off a panel alarm in the control room. The options available to plant management include reducing boiler load (load could possibly shift to other modified recovery boiler) to reduce inlet particulate loading, re-distributing the gas flow between the chambers to reduce gas flow through the chamber with the TR-set out, change mode of operation (full-wave or half-wave), or isolate the chamber and cut-out the wire after the chamber cools down (complete turnaround time is approximately 5-5 hours). The plant personnel indicated that any combination of these may be used (approximately 12 options available) depending upon the particular situation.

The hopper design is somewhat different than normally encountered with dry bottom precipitators. The hoppers, rather than being the usual trapezoidal design, are flat bottomed using drag-line conveyors to move the caputured particulate matter to a trough in the hopper bottom. The particulate is mixed with black-liquor in this trough by a screw (ribbon) conveyor and the black liquor is recirculated into the recovery boiler. The hoppers (and precipitator) are steel shelled, insulated, and tiled-lined.

Removal of the particulate matter from the plates and discharge wires is accomplished by use of falling hammer rappers. These rappers impart the necessary energy horizontally rather than vertically as typically encountered with other rapper designs. Variation of the rapper intensity may be changed by changing the rapper hammer weight. There are two selections for rapper control; automatic and manual. The automatic cycle normally raps once every 15 minutes. Manual control reduces the rapping sequence to once/minute. There are no other choices and the rappers are those typically used by the vendor. Thus, the degree of rapper control is somewhat limited.

The source or vendor did not perform either particle resistivity tests or gas distribution tests on the precipitator. However, the vendor did perform scale model tests to determine proper gas distribution. Overall, we feel the design is basically a good one and the Company desires to maintain compliace with the applicable regulations.

5. Control Equipment Performance Evaluation

This unit was initially started up in December 1976. However, continuous operation was not achieved unitl March 1977. There have been no problems with the rigid frame design itself, e.g., warping of plate and wire supports when cooling the unit down. The effect of expansion/contraction due to temperature changes is usually an area of major concern in rigid frame designs and can lead to serious problems. There have been a number of problems and malfunctioning of various components. These problems include failure of rapper drive mechanisms, failure of hopper conveyors, broken wires, and particulate build-up on the supporting framework of the precipitator.

The source has been unable to operate the control equipment for more than about 60 days before requiring some form of corrective maintenance. The most common failures are broken wires, which are occurring at a rate of 2 wires every 3 months, and failure of the rapper drive mechanisms (about 1 every 3 months). There does not appear to be a specific reason for these failures although the plant personnel have not specifically tried to relate malfunctions to the operating conditions.

The plant personnel have indicated that some problems have occurred because of the physical size of the unit. Internal support frames are necessary and these frames allow particulate to build up and cause electrical grounding problems. These support beams also hamper internal access to the precipitator. Furthermore, there is very little clearance at the top of the precipitator to the support frames (about 1 foot, no penthouse). The source views this as an aspect overlooked during design but is not critical to the operation of the ESP.

The plant personnel also addressed several other problems which have occurred but should be considered as "unusual" problems. First, a TR-set failure occurred shortly after start-up. This was attributed to a defective unit which was replaced under vendor warranty. Second, there are specific instances where the source was out of compliance with the opacity standard while emissions were one-third the mass-emissions limit. This will be discussed further in Section 5.4. Lastly, there have been occasions where the source has isolated one chamber for maintenance only to have the other chamber of the ESP build up with particulate matter (i.e., particulate cannnot be removed from the ESP fast enough). This situation requires completion of maintenance, putting the chamber back in service and removing the other chamber from service to clean-up particulate build-up. This situation can "ping-pong" back and forth until the source is forced to go off-line or severely reduce load to remedy the situation. However, none of the occurrences mentioned in this section are known to have caused an emission in excess of mass-emission limitations.

5.1 Preventive Maintenance

A suggested preventive maintenance procedure was not recommended to the source by the vendor. Thus, the source has had to develop a procedure of its own. The following are checked during each shift:

1. TR-set readings
2. Rapper drive operation
3. Conveyor drive
4. Ribbon mixer drive

For daily operations these seem sufficient but no specific procedure has been documented by the source. The precipitator chambers are inspected when corrective maintenance is required. Any conditions noted or additional preventive maintenance required is performed at this time. Ideally, plant personnel would like to extend this period between inspectiosn to once every six months, though currently, corrective maintenance requiring a chamber out of service is occurring 2 to 3 times every three months. The semi-annual inspection would normally require 24 to 30 hours total from boiler shut-down to start-up. The number of manhours required presently for maintenance work is approximately 140 per month (includes all aspects).

The transmissometer installed on the stack has had no preventive maintenance performed since installation and the unit has performed very reliably. Access to the monitor requires climbing approximately 150 ft. up the stack.

5.2 Recordkeeping and Monitoring

No records are kept on either the operation of or maintenance performed on the precipitator. No TR-set data is recorded on any routine basis and any taken is not kept for any length of time. The location of the TR-set panel meters is in the power substation and none exist in the control rooms. We would recommend the implementation of, at a minimum, recording daily TR-set data, recording the nature of all malfunctions, (e.g., exact location of broken wires), corrective and preventive maintenance performed, and recording of process data. This should allow the source to correlate, to some degree, the occurrence of a malfunction with operating conditions and preventive maintenance and help to optimize the preventive maintenance program. The State agency can require this recordkeeping as part of the permit requirement but has not done so.

A transmissometer located on the stack is operating although the data it could provide is useless to this study. The plant has made a modification by the addition of the exhaust of hogged wood-waste fired boiler to the stack. The opacity seen by the transmissometer is the combined opacity of both the recovery boiler and wood-waste boiler. We would recommend the relocation of the opacity monitor at the outlet of the precipitator and the wood-waste boiler. Converters may be incorporated to correct for path-length differences in opacity.

5.3 Emissions

The source has not performed a formal stack test for the State agency to satisfy the requirements of the permit. However, a number of performance tests (Method 5) have been performed by the Company to experiment with various ESP operating conditions (boiler load ~80% capacity). These tests have included operating with only one chamber on-line. The results show, and we have no reason to disagree, that there should never have been an occurrence of excess emissions above the mass-emissions standard. An emissions profile is shown in Figure 1 which includes the results of the stack tests and our estimation of potential errors. Normal process operation should reveal an emission rate of 0.316 lb/air dried ton of pulp which is one-tenth the mass-emissions standard.

Compliance with the opacity standard is not always as easy. The Company provided results from their special performance tests to confirm this and a correlation of these results is shown in Figure 2. Although violation of opacity standards is typically indicative of mass-emissions violations, this is not true in this situation. It should be noted no interferences were caused by the hogged wood-waste boiler during these tests. The Company feels the State agency relies too heavily on opacity to determine compliance.

5.4 Spare Parts Inventory

The vendor maintains an adequate supply of spare parts for use by their customers. However, in recent months the vendor has reduced its inventory of spare parts. The source has expressed concern over this occurrence. The plant keeps a spare TR-set, 1 complete rapper assembly (in parts), and extra conveyor drives and bearings in their spare parts inventory. These parts seem adequate in light of the operating and maintenance history of the equipment. Most parts not on hand require less than one week to obtain from the vendor. No incidents of excess emissions can be attributed to the lack of spare parts availability.

5.5 Other Comments

The State agency has placed little or no pressure on the source and appears to have had minimal contact during inspections. The inspection procedures used by the State agency is extremely superficial. The inspector merely observes stack opacity and does not look at the general condition of the equipment, observe TR-set readings, or even go to the control room to observe panel indicators. Furthermore, the State has not required any recordkeeping by the source. Thus, it is understandable why the source is concerned with the State agency's reliance on opacity to determine compliance in light of the previous

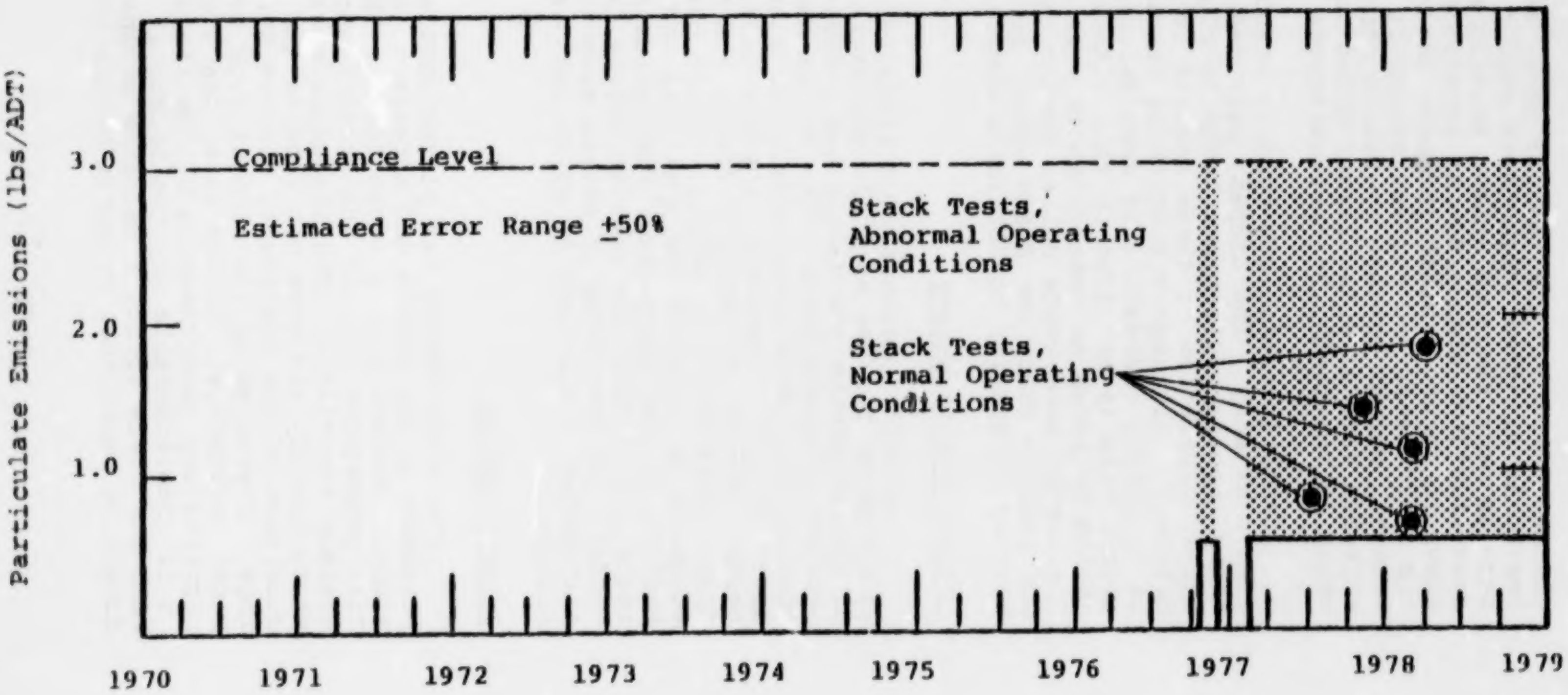


Figure 1. Estimated Emissions Rate for Source 6.

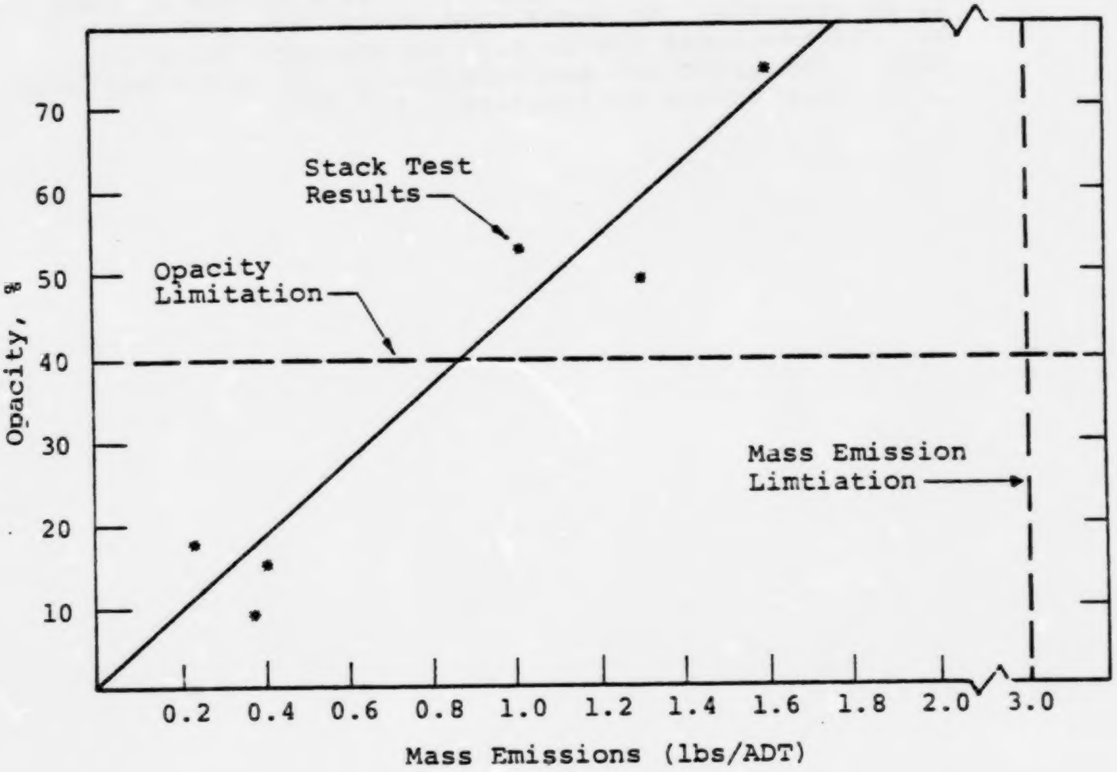


Figure 2. Relationship Between Opacity and Mass Emission Limitations.

discussion. The State inspector apparently has little interest in the actual compliance status of the source or in the operation of the equipment. Although the source is well-controlled and appears conscientious in its effort to maintain compliance, a self-imposed recordkeeping program may help protect the source from the inadequate inspection techniques used by the inspector.

6. Costs

Limited cost data was available to us. Installed capital costs for the control equipment was estimated at $22 million (1976 dollars). This estimate appears to be accurate. No annualized costs were available to us. As mentioned previously, maintenance labor accounts for about 140 manhours/month. At a $10 per hour rate, this totals approximately $17,000.

INSPECTION REPORT

Source 7

1. Summary of Visit

This grey iron foundry was visited in the fall of 1978 for an evaluation of the performance, operational problems, and maintenance procedures of its low energy wet scrubber. Based on information obtained during the inspection and from State Agency files it appears that the Source was never in compliance during the period 1970 through 1977. Initial noncompliance was the result of an uncooperative attitude of the source. The State Agency subsequently developed a good working relationship with the source. However, compliance was again delayed because of the slowness of the equipment vendors to deliver workable designs, delays in obtaining construction materials, failure of a construction contractor to meet his schedule, and the tardiness of the Water Quality Branch of the State Agency in reviewing water quality implications of the control equipment. After construction of the control system, it was discovered that the design was grossly inadequate. The equipment engineers could not honor any guarantees, written or implied, because they had gone bankrupt.

2. Chronology of Source/Agency Interaction

1972 - May. Temporary permit issued. Allows discharge of air contaminants for seven months, at which time proper controls are to be in operation.

- December. Source allows permit to expire. Source has made little effort to plan a control system.

1973 - Winter and Spring. Source operates without a permit. Source has difficulty obtaining workable plans from vendor.

- July. Temporary permit extended for five months.
- Fall. Plans for equipment developed by source and vendor.
- December. Temporary permit expires.

1974 - April. Control system construction begins.

- July. Temporary permit is renewed for five more months.

- August. Complaint received concerning sulfurous odor and smog. Agency explains that the compliance schedule is already in effect.

- December. Temporary permit expires again.

1975 - March. Another complaint received. Agency again explains that a compliance schedule is in effect.

- August. Permit issued. Control equipment to be constructed within seven months. Source permitted to operate for three years thereafter. Special order of consent entered into. Source agrees to a list of construction milestone deadline dates.

1976 - March. Source misses compliance deadlines due to three month delay by construction contractor. Enforcement action deferred because of good faith effort of Source.

- May. Additional three month delay in compliance because Water Quality Branch of State Agency requires time to issue water quality permit.

- July. Special order of consent revised to allow two additional months time.

- December. Control equipment operational.

1977 - Winter and Spring. Source acknowledges six visits by Agency which are not reported in Agency files. Source performs own stack test and finds emissions to be in violation. Equipment manufacturer has gone bankrupt.

- August. State conducts stack test. Particulates in violation.

1978 - A stack test conducted by the source indicated emissions have recently been reduced to within regulatory requirements for the first time.

3. Process and Control Equipment Design

The foundry has two cupola furnaces for melting grey iron. The cupolas are operated on alternate days. Each day one cupola is in production while the other is being cleaned and/or re-lined. The cupolas are initially charged with a layer of metallurgical coke. After ignition scrap iron, limestone flux, and additional coke are added. The charge is brought up to about 3300°F, at which time slag and molten iron can be drawn off. Each cupola handles up to 24,000 lbs of raw materials (scrap iron, flux, and fuel) per hour. The foundry's scrap iron and steel feed stock contains significant quantities of foreign materials such as paint, grease, oil, carbon, sand, and grit. The process produces an assortment of fly ash and other particulates. Uncontrolled emissions are estimated to be 240 lb/hr max. The principal products of the foundry are municipal and construction castings.

The control equipment consists of a 10 ft diameter, 36 ft high spray chamber type primary separator followed by a venturi wet scrubber, with an impinger type collection vessel (see Figure 1). Draft is induced by a 100 hp fan which exhausts to a 60 inch diameter, 72 ft high stack. The flow rate is 40,000 cfm max. The system uses up to 200 gal. of water per minute.

The foundry was constructed in the 1920's and is located at the perimeter of a town of more than 20,000. There are two houses approximately 600 ft from the plant and several commercial establishments are located within 1,000 ft of the plant. The plant employs a total of about 200.

4. Design Evaluation

The control system at the foundry has presented several problems since its installation. The system has not provided the degree of particulate removal that its designers predicted. Several of its components have suffered significant corrosion, requiring repair or replacement. In addition, the State Agency water quality section has recently required recycling of the scrubbing water. It is quite possible that recirculation will increase the system's propensity for corrosion.

When the Source was asked by the State Agency in 1972 to develop plans for controlling air emissions at the foundry, the firm had no experience or expertise in air pollution control equipment. During the initial phase of selecting the control system, the Source made numerous contacts with consultants and made several visits to observe operating control devices. The Source eventually considered two basic options presented them by various vendors: a conventional venturi scrubber and a recently developed "low energy" type

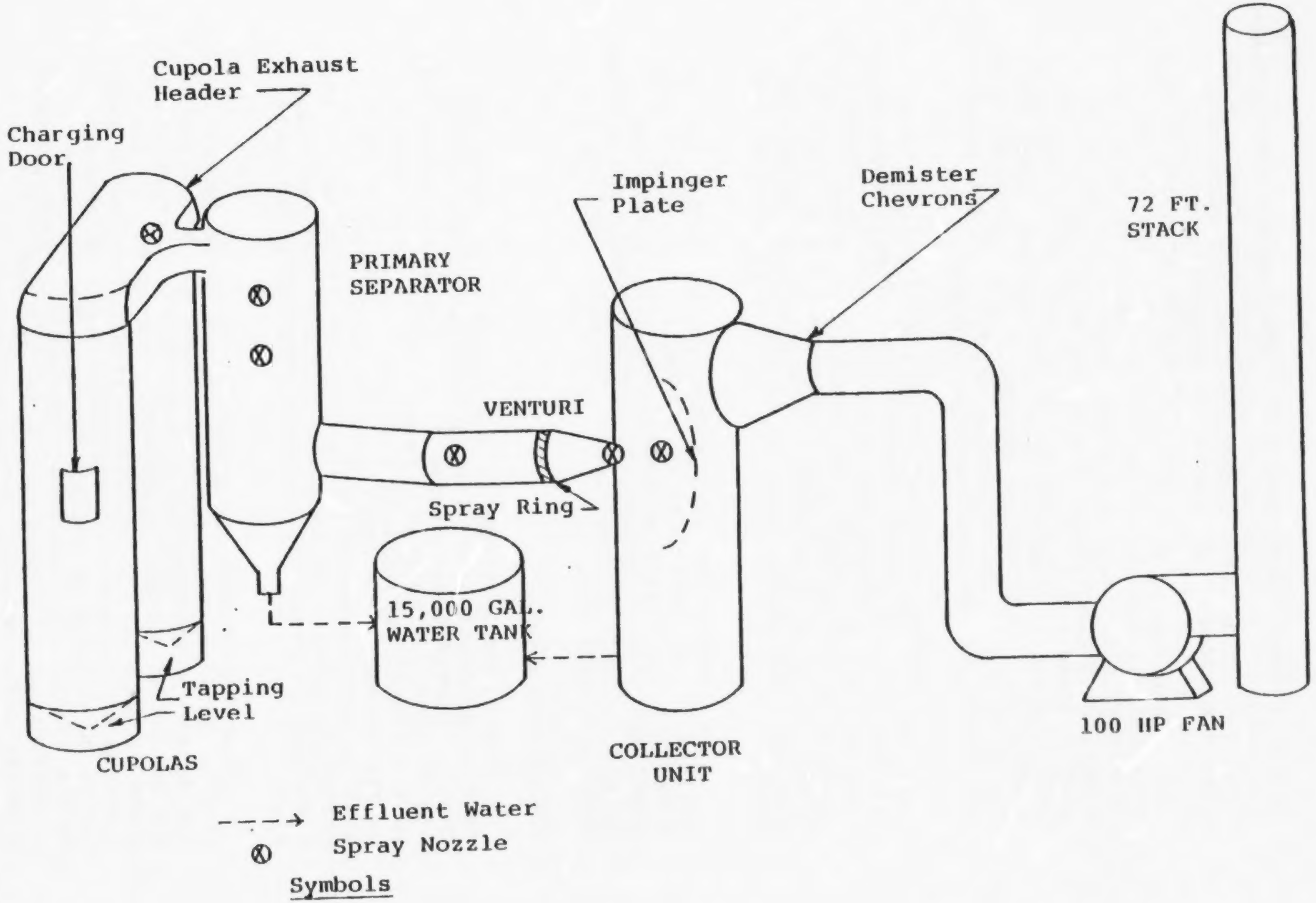

Cupola Exhaust Header
Charging Door
PRIMARY SEPARATOR
Impinger Plate
Demister Chevrons
72 FT. STACK
VENTURI
Spray Ring
15,000 GAL. WATER TANK
Tapping Level
CUPOLAS
COLLECTOR UNIT
100 HP FAN
- - -→ Effluent Water
⊗ Spray Nozzle
Symbols

Figure 1. Source 7 Equipment Configuration.

scrubber. (The source apparently never considered a bag filter as a viable control option.) As presented by the vendors, the low energy scrubber had two distinct advantages over the conventional venturi design. First, it required a 100 hp fan versus a 350 hp fan for the conventional venturi. This lower power requirement was very advantageous, because the Source feared that high pollution abatement costs could threaten the plant's existence. Secondly, a low energy scrubber operates with a much lower gas velocity, making erosion/corrosion problems less likely than in the higher velocity system. Erosion/corrosion is a common problem in equipment exposed to high velocity, high temperature foundry gases.

The installation of the control equipment was delayed by unavoidable construction problems. During the initial stages of development, the vendor had difficulty finding a location for the equipment in the crowded foundry yard. The Source had to reject several designs before a practical design was developed. Then fabrication of the equipment was delayed several months because mill stock was not available on the steel market for the system's vessels and ducts. During construction, the concrete contractor would not meet his obligations for pouring the foundations and this delayed the project another three months. Finally, the start-up of the equipment was delayed an additonal three months because the State needed time to issue a water quality permit.

The control equipment went on line a full four years after the start-up date specified in the source's first temporary permit. The temporary permit was renewed twice during this period. In summary, the initial year of delay was due to an uncooperative attitude of the source. The source subsequently made a good faith effort to install control equipment and was prevented from doing so by tardiness of the equipment designers, materials suppliers, construction contractors and the water quality division of the State Agency.

Since start-up the Source has had to alter the equipment several times. They have added or relocated spray nozzles on several occasions in an effort to improve efficiency. Although the vendor predicted a 99.9% removal efficiency, the emissions have not met the State requirements of 22 lb/hr which represents about 91% control. The Source has also had to replace the exhaust header from the cupolas and the impinger with stainless steel (originally carbon steel). The Source has also switched the spray nozzles from compressed air driven to water pressure driven, because of high compressed air requirements.

Because the control equipment does not operate continuously, freezing of the water lines has been a problem in the winter. The Source has not been able to completely solve the problem and must have operating personnel flame heat some of the lines on cold mornings.

In summary, the control system at the plant has experienced a series of problems since the Source decided to install it. The most significant problem has been a lower than expected efficiency. The second most significant problem was an inappropriate choice of materials. The Source has been unable to obtain technical assistance from the firm which designed the equipment because it has recently gone out of business.

5. Performance Evaluation

5.1 Preventive Maintenance

The Source preventive maintenance program consists of a daily inspection before ignition of the cupola. During this inspection the spray nozzles are checked, as are the impinger and the demister chevron. Nozzles are cleaned or replaced as needed and the demister must be scraped on occasion. Ductwork and vessels are also inspected for corrosion and the fan blades are washed whenever they become fouled.

5.2 Recordkeeping

The Source does not keep a specific record log devoted to the control system. There is no instrumentation to measure the emission rate of the plant or the opacity of the plume, nor is there instrumentation to measure air temperature, pressure drop across the system, or the fan electricity usage. The only parameter monitored is the water usage.

5.3 Emissions

Emissions at the foundry were measured to be 94 lb/hr during a stack test conducted by the Source in 1977. This is more than four times the maximum allowable. Four months later the State conducted a stack test which showed that the source was emitting a much lower 41 lb/hr, which was still 190% of the permitted rate. If this figure is typical, the plant emits approximately 52 tons per year. (The facility is operated for 2,500 hours each year.) The Source estimated that its uncontrolled emissions were about 240 lbs/hr

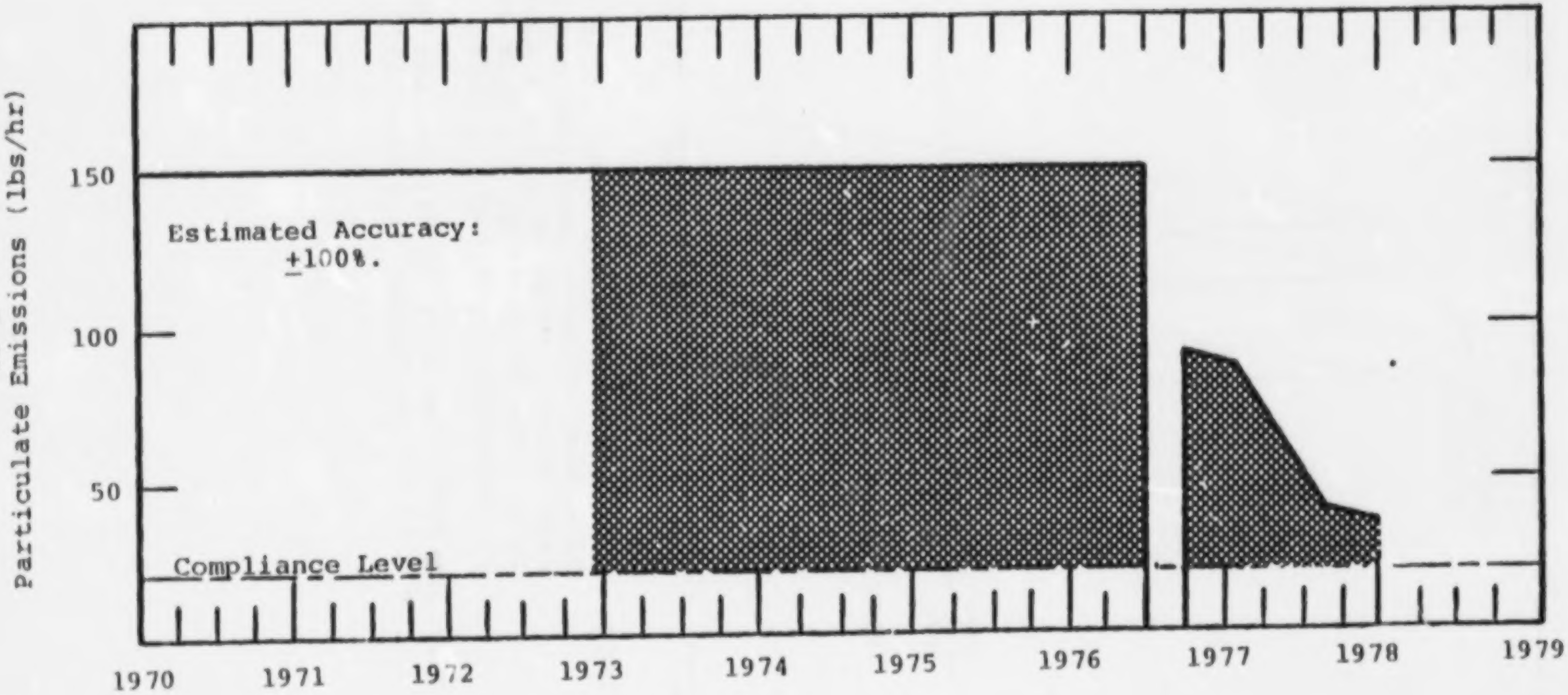
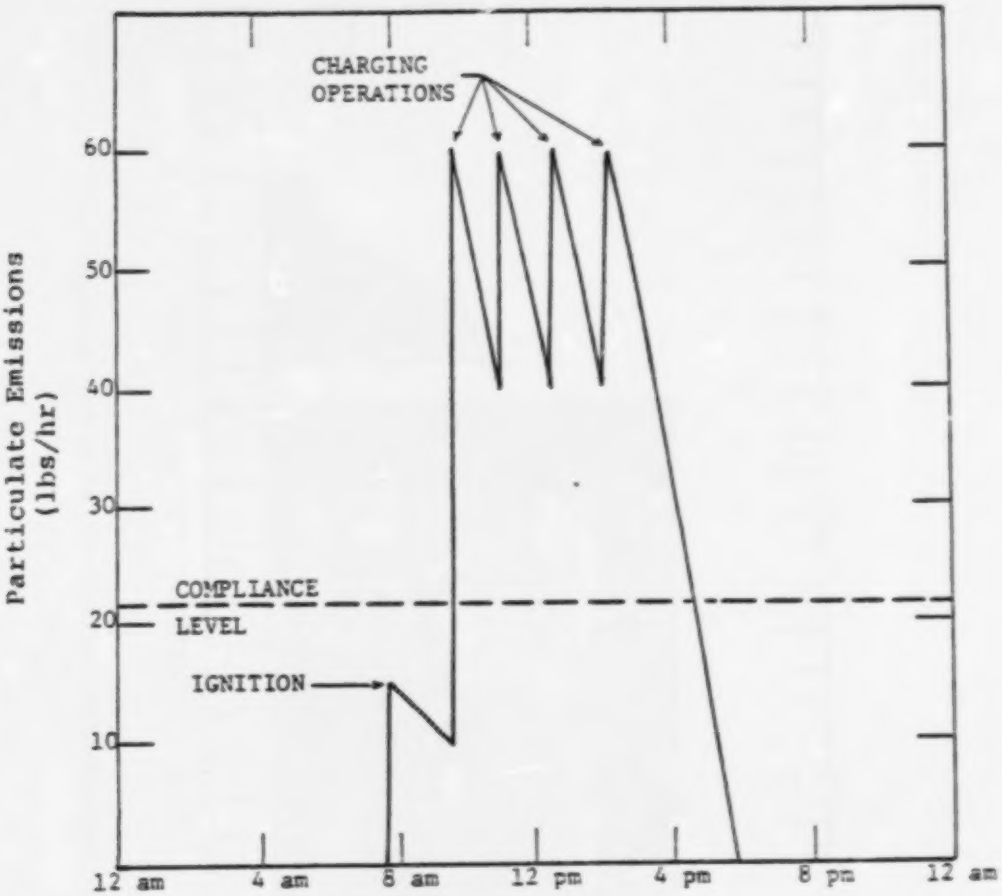


Figure 2. Estimated Particulate Emissions Rate for Source 7.



NOTE: This graph is highly speculative as there have been no tests performed and no records kept which provide data for a diurnal profile. The error range for this estimate is therefore quite high (± 100%).

Figure 3. Estimated Diurnal Particulate Emissions of Source Number 7, Summer 1977.

or about 300 tons per year. Based on the above estimates two emissions profiles have been constructed. Figure 2 depicts the estimated annual emissions from 1970 through 1977 and Figure 3 depicts the estimated diurnal emissions. From these figures it is estimated that between January 1970 and January 1978, the Source emitted approximately 1,190 tons of particulate matter above the amount allowed by State regulations. If the Source had been conscientious in its efforts to install an effective control device, and if the State Agency had been more experienced in reviewing the control system designs, excess emissions may have been prevented as early as 1973. Had this been the case, as much as 700 tons of the excess emissions would not have been emitted.

5.4 Spare Parts Inventory

The Source keeps a spare parts inventory of approximately $5,000 for its control system. Components kept in stock include: 10 spray nozzles, an extra fan motor, and an extra water pump. Control system outages have rarely occurred due to lack of spare parts. Since the system became operational the foundry has lost only two days production because of control system component failures. One day was required to replace the fan motor. Corroded ductwork and vessels have been patched on weekends.

One item that could cause a prolonged shutdown should it fail is the fan. The Source does not keep a spare one in stock and delivery could take up to two months.

6. Costs

The total purchase cost of the foundry control system was about $300,000. Not included in this figure is 2 weeks lost production during installation of the equipment, and two days lost production since then for repairs.

Operating costs include an undetermined amount of power consumption for the fan and water pump, about 10 manhours per week for inspection, about 10 manhours per week for cleaning of nozzles, ducts, and the demister, and replacement of nozzles (nozzles typically last less than 1 year). Non-scheduled maintenance for repair of corroded components required more than 1,000 manhours as well as an undetermined amount of stainless steel during the first year of operation.

INSPECTION REPORT

Source 8

1. Summary of Visit

The selection of this source for the study was based on the recommendation of the State agency regional office. They had found the plant personnel very cooperative and conscientious in the operation and maintenance of the control equipment. This plant has had relatively few problems. Plant personnel keep excellent records concerning the operation and maintenance practices.

2. Chronology of Source/Agency Interaction

1971 - December. Source applies for temporary operating permit. Extensive modifications by the source are required.

1972 - January. Complaint made by citizen about source and neighboring company.

- May. Agency grants temporary permit to source.

- November. Source notifies Agency of purchase order for "low-odor" recovery boiler and modifications to be made to an existing recovery boiler. Temporary permit is modified as actions to be taken by the source become finalized.

1973 - May. Source reports that plans and construction are on schedule.

- August. Source applies for permit to construct and operate two power boilers. Routine in spection by Agency to be certain all point sources are covered by temporary permit. Source applies for permit to construct and operate ESP for new recovery boiler.

- October. Citizen complaint concerning soot and dust. Agency explains to citizen the volun tary actions taken by the source and the costs of modifications. Agency grants permits for two power boilers and ESP on new recovery boiler. Source applies for permit on third power boiler.

- *November*. Source applies for permit to construct and operate new ESP for modified recovery boiler.

1974 - *January*. Agency grants permit on third power boiler.

- *February*. Agency grants permit for new ESP on recovery boiler.

- *April*. Source requests extensions on some parts of temporary permit due to delays. Extensions are granted.

- *May*. Source applies for permits to construct and operate scrubbers on lime slakers.

- *July*. Agency grant permit for source to construct and operate scrubbers on lime slakers.

1975 - *February*. State inspects source to observe construction progress. Construction is on schedule.

- *December*. Complaint from mayor of adjoining town (odors). Asks for town meeting.

1976 - *May*. State inspects source to observe construction progress. Construction on-schedule, some instrumentation problems.

1977 - *January*. Routine inspection; all sources operating in compliance with opacity regulations. Apparent initial compliance with mass emissions regulations.

- *February*. All sources observed to be in compliance with opacity limitations.

- *May*. Stack tests demonstrate recovery boilers operating in compliance with mass-emissions limitations. State agency responds to complaint by a citizen to EPA administrator. Citizen is advised by State agency on progress made by source.

- *June*. Routine inspection; all sources observed to be in compliance with opacity limitations.

- September. Source applies for renewal of permit and for consolidation of all permits under one. Routine inspection; all sources observed to be in compliance with opacity limitations.

- December. Agency grants consolidated permit to source. Routine inspection; all sources observed to be in compliance with opacity limitations.

1978 - May. Source notifies agency of malfunction on ESP #2. However, in compliance with opacity limitations.

- June. Routine inspection; malfunction corrected. All sources observed to be in compliance with opacity limitations.

- September. Routine inspection; all sources observed to be in compliance with opacity limitations.

3. Plant Description

Two electrostatic precipitators serving the recovery boilers are the subject of this inspection. One recovery boiler is a modified source which has had a strong black liquor oxidation system retrofitted to the existing recovery boiler. The other unit is a new "low-odor" recovery boiler with a large surface area economizer. Both units are controlled by wet-bottom type electrostatic precipitators.

The operation of each recovery boiler is related to the production level of the plant. The inlet loadings of each ESP is related to the boiler operation conditions. As will be discussed below, the size of the units are different and there are many ways to balance the load between the boilers to accomodate operating conditions.

The primary purposes of a recovery boiler are to recover the heating value of the organic matter in the black liquor and to recover Na_2CO_3 and Na_2S. The particulate matter generated by the recovery boiler may include Na_2CO_3, Na_2SO_4, and possibly small amounts of Na_2S. This particulate matter is captured by the ESPs and is recycled back into the black liquor for combustion. The recovery of Na_2CO_3 and Na_2S from the boiler occurs as a smelt from the bottom of the boiler where it is dissolved to form "green liquor." There is an economic incentive to recover these materials.

The two recovery boilers discussed are the only two in use at this kraft pulp mill. The other recovery boilers once in use have either been converted to power boilers or have been retired from use. The rated capacities of these recovery boilers are 1.5 million lbs of black liquor solids/day (#1) and 2.5 million lbs/day (#2).

4. Control Equipment Design Evaluation

A. ESP on #1 Recovery Boiler - The ESP on the #1 recovery boiler is a weighted discharge wire design handling 208,000 acfm @ 325°F. The gas flow is split into two parallel chambers, each chamber containing 4 fields (full-wave operation). This unit was designed for a 99.0% particulate removal efficiency. Efficiency was further guaranteed to be 98.4% and 98% with one and two TR-sets out, respectively. And, with one chamber out of service (total gas flow through one-half of the precipitator), the removal efficiency should be 90%.

This precipitator has a total surface area of 75,600 ft^2 and 1680 discharge wires (30 ft. long). Calculations reveal an SCA of 360 ft^2/1000 cfm. The gas is brought out of the recovery boiler, (cascade evaporator), through a set of turning vanes and a perforated plate to give an even gas flow distribution, and into the precipitator. Upon exiting the last fields the gas passes down to an existing I.D. fan and out an existing stack previously used for the old ESP and recovery boiler. Sampling ports are provided in the inlet and outlet ducts for stack testing. Access to the precipitator top and bottom are provided by catwalks. The precipitator bottom is roughly 95 ft. above ground level and the top of the precipitator is approximately 130 ft. above ground level.

Particulate removal from the plates and discharge electrodes are accomplished by air vibrators (16 for discharge electrodes, 36 for collecting plates). Removal of recovered particulate from the precipitator bottom is accomplished by 4 paddle agitators which mixes the captured particulate with black-liquor for recycling.

B. ESP on Recovery Boiler #2 - The precipitator on recovery boiler #2 is considerably larger than that on #1 for two reasons. First, the gas flow handled by this precipitator is approximately 1½ times greater than that of #1. Second, the composition of the composite black liquor is somewhat different. The liquor entering the #1 recovery boiler is a composite of 50% solids whereas the liquor entering recovery boiler #2 has 63% solids. This, too, has an effect on particulate loading into the precipitator.

The precipitator is designed to handle 321,000 acfm @ 475°F with a guaranteed particulate removal efficiency of 99.5% after rapping losses. Furthermore, efficiencies should remain above 99% with one TR-set out and 93% if the total gas flow is passed through one chamber only. There is a total surface area of 133,920 ft^2 and 2976 discharge electrodes (SCA = 420 ft^2/1000 cfm). The gas flow is split into two parallel chambers each with 5 fields. Even gas flow distribution through the chambers is accomplished by turning vanes and a perforated plate. Rappers are the same type found on unit 1 but are required in greater numbers (26 rappers for discharge electrodes, 64 for collecting plates). Particulate removal from the wet bottom is also accomplished with paddle agitators mixing with black liquor for recycling.

C. Design Concepts Common to Both Units - Most critical design parameters were prepared by the Company engineers and collection efficiency was specified to the vendor. There were no in-situ resistivity tests or model studies conducted by either the vendor or the source. However, there has been considerable experience with ESPs on recovery boilers and, furthermore, the Company has had experience with these particular combinations of boilers and precipitators by their respective vendors at a plant in the western United States. A considerable number of operating problems and high maintenance requirements have been encountered at the western plant and the necessary corrections to these problems were incorporated into the design of the equipment which we examined. This, perhaps, explains the relatively successful operation of these units.

5. Performance Evaluation

These units have operated successfully since start-up in late 1976 and early 1977. There were some problems with excessive wire breakage after start-up. These wire breakages have been reduced to approximately 5 or less per month recently. Plant personnel felt that some of the problems have been related to boiler operation (off/on operation during plant start-up) and that the wire breakage they are experiencing now is still related to operation during start-up. As all the original wires that were subject to the start-up operation are gradually replaced the number of broken wires per month may decrease.

Wire breakage has been fairly random throughout the precipitator. The exact location of each wire breakage is noted in a maintenance log and monitored to detect any pattern. The breakage has occurred primarily at the wire hanger and appears to be a mechanical failure rather than failure due to excess sparking.

Corrosion has not been a serious problem for either precipitator. Each unit is well insulated and operates well above the acid dewpoint. The precipitator has a steel shell and bottom and is not tile lined. There has been a small amount of corrosion around the access hatches but this apparently is not serious.

Adequate clearance is available to convert these units to dry bottom precipitators (this alternative was mentioned in correspondence with the State). However, no changes are planned in the near future to convert to dry bottoms. The agitators do an adequate job of removing particulate from the precipitator. There is a gradual build-up of material between the reach of the four agitators which must be periodically removed. Failure to remove the material because of gradual build-up or agitator failure could cause plate warpage, plate misalignment, and/or short-circuiting of sections of the precipitators. One agitator failure has been noted in the State files on the #2 precipitator. There have been no reports of plate warpage and the only modification to the plates occurred during construction when some plates developed cracks. There have also been some insulator problems requiring rebuilding of insulator supports.

Generally, with one chamber out for maintenance the ESP should remain in compliance with both mass emission and opacity regulations. Furthermore, the boilers can be operated at reduced load to accomodate a chamber out of service. Generally both boilers do not run at full-load at the same time. There should be relatively few circumstances where these units operate out-of-compliance with either regulation. The State and the source keep records of contacts concerning visible emissions and malfunctions. This year, to date, the State has been contacted four times concerning visible emissions or malfunctions. This notification occurs primarily during start-up (which is not considered a violation) to keep the State office aware of the situation in the event a citizen complaint about opacity is made.

5.1 Preventive Maintenance

Since both precipitators average a total of 5 broken wires per month, or because there are other reasons to isolate a precipitator chamber, each section receives a monthly inspection while the chamber is down. These inspections detect other problems such as a gradual solids build-up and the need for wash-down of the precipitator bottom. Every 3 to 4 months the unit is shut down to replace broken wires and wash out the bottom to remove build-up between the agitators. The "monthly inspection" generally requires a total of 8 hours downtime on any given chamber and the quarterly wash-out and wire repair, requires approximately 16 hours. A 1 hour warm-up period on the ESP is required before re-energizing. The slide gates to isolate a precipitator chamber are operated at least once per week to keep them in working order.

As with many boilers, there is an annual inspection of the boiler and ESP. Parts examined and corrected are broken wires, particulate build-up, plate alignment, inlet ductwork, and turning vanes. Such annual outages generally require only a few days downtime.

Oil level is checked in the transformers whenever electricians are looking over the electrical system, unless specific problems have been experienced. The oil dielectric strength is checked every 4 to 5 years.

As mentioned previously, records are tracked to identify any recurring problems in any specific area and identify solutions to these problems.

5.2 Recordkeeping and Monitoring

The readings from the TR control cabinets are taken every 2 hours as well as a notation of the status of the boiler and ESP (normal, shut-down, or warm-up). An interesting design aspect encountered at this source is the placement of remote panel meters (primary voltage and amperage) in the control room with the other process related monitoring equipment. Very few other sources in the State have done this. Primary voltage and current are monitored and recorded and spark rate is monitored but not recorded (spark rate is generally around 0-3/min and almost always less than 10/min). These records are kept for 3-4 months to diagnose any short-term problems and then discarded.

Continuous monitoring (opacity) of the recovery boilers has not been required in the past but may be required in the future. An opacity monitor is required on one of the power boilers and this was being installed during the visit.

Extensive recordkeeping of all maintenance has been instituted by the source. Positions of wire breakage and location of particulate build-up are noted in a maintenance log. Work orders outlining work required and areas where the work was necessary have been kept since operation began. Because of the limited scope of the project, time could not be taken to cover the individual maintenance logs as extensively as we would have liked.

5.3 Emissions

Both units were tested in May 1977 at or near full capacity. The allowable emission rate is 3.0 lb/ton of air dried pulp. ESP #1 operated 99.7% efficiency and had an emission rate of .36 lbs/ton. ESP #2 was tested at 99.8% efficiency with an emission rate of .3 lbs/ton. There is no occasion to our knowledge that the source has operated out of compliance with either mass-emission or opacity regulations. Typically stack opacity is between 0 and 5%. The estimated emissions are summarized in Figure 1.

5.4 Spare Parts Inventory

The spare parts inventory for both units is quite extensive and is recorded on a computer listing. Only a short summary of spare parts is presented below:

Dischare Wires (100-200)
Bearings
Silicon Rectifiers
Insulators
Vibrators
Gaskets
Rapper Assembly
Rapper Anvil

The list is more extensive than that suggested by the vendor. It should be noted that no problems or precipitator downtime have been caused by the lack of spare parts availability. Parts not on hand may be available from other sources locally or other kraft mills (loan).

5.5 Other Comments

The source was concerned with the results of this study and how these results will be used. They feel that their working relationship with the State is excellent and would not want anything to jeopardize this relationship. The State personnel responsible for this region apparently agree. The personnel were very cooperative and maintained excellent records. Overall impressions of the performance of source and agency personnel is that both are doing an excellent job in maintaining

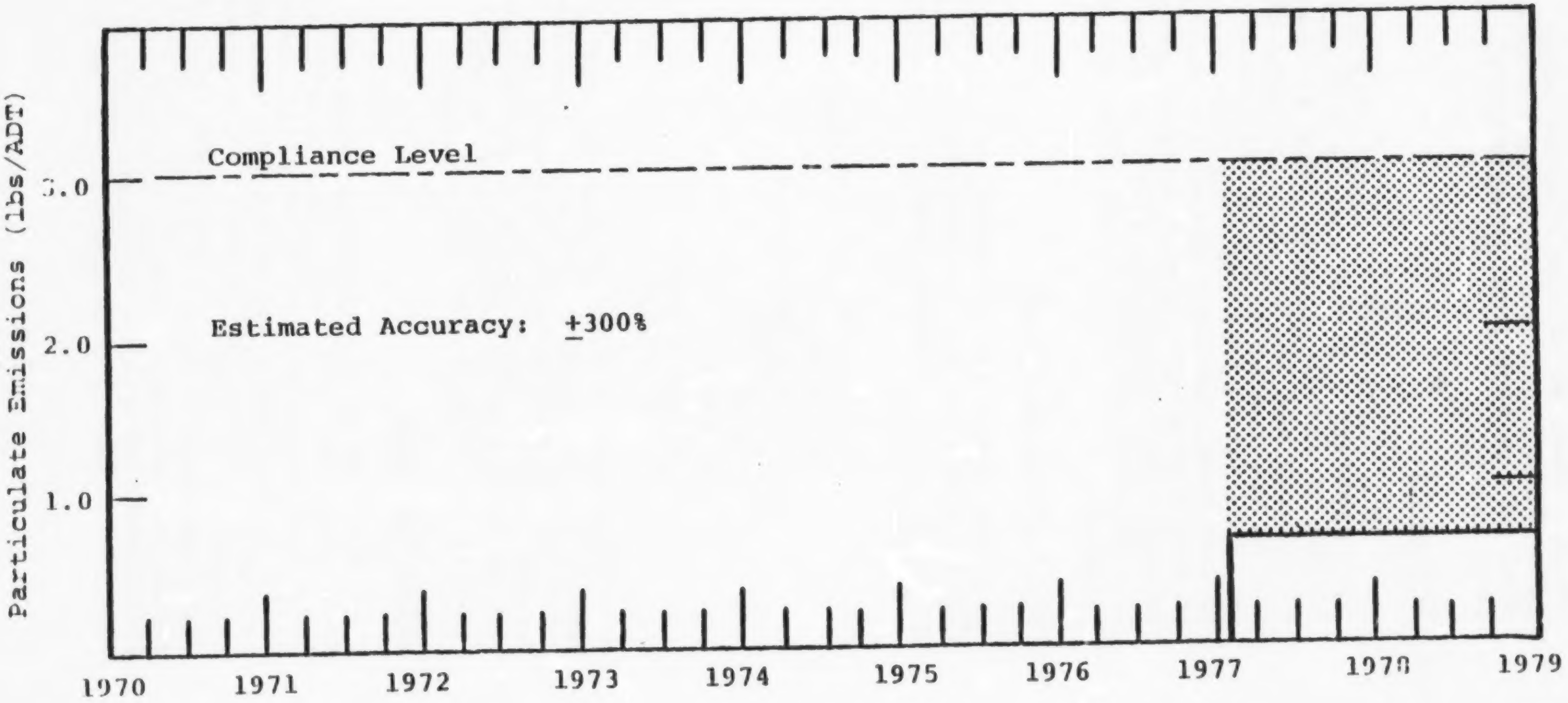


Figure 1. Estimated Particulate Emission Rate for Source 8.

compliance. Our only criticism is that we would have liked to have seen the ESP/boiler records kept for a longer period of time.

Since 1972 a total of 4 complaints have been registered implicating the source and/or a neighboring textile plant. The State has explained to the complaintants the efforts that the source has undertaken to reduce sulfur emissions (TRS compounds such as H_2S) and particulate emissions. All evidence indicates that the source has, to the best of its ability, maintained scheduled compliance and target dates and has made "good-faith" efforts to comply with regulations.

The plant personnel emphasized that if an operation or maintenance regulation is proposed on the basis of this study, the regulation should be realistic in its requirements. For example, to require the source to maintain excessive data would be unnecessary and meaningless in that neither the source nor the State agency has the time or the resources to analyze such excessive data in much detail.

6. Costs

Initial estimated installed costs of the ESPs are $4 and $6.9 million for units 1 and 2, respectively. Annual maintenance costs were provided from 1977 through August 1978. Costs are highly variable month-to-month, and an exact accounting of all costs were not available to us in the time allotted although these could likely be determined from work orders kept on record. All costs are summarized from computer read-outs.

Summary of Approximate Maintenance Costs

	#1	#2
1977	$11,100	$12,500
1978 (through August)	$11,900	$10,200

INSPECTION REPORT

Source 9

1. Summary of Inspection

Company designed, locally fabricated wetted wall cyclones are used for particulate control on a rotary drier. The system has operated in marginal noncompliance with visible emission limitations for a period of 2 years. Two equipment modifications have been necessary in order to maintain this level of performance. We suspect that severe erosion could soon develop in the inlet sections of both cyclones due to the extreme gas velocities. The State has postponed a planned stack test for several months at the request of the Company.

2. Chronology of Source/Agency Interaction

1976 - January. Start-up of cyclones.

- May. Plant in compliance with visible emission limitations during routine inspection.

- May. Routine inspection; excessive visible emissions noted for a period of 10 minutes. Opacity values during this period were not recorded.

- June. Two special inspections; visible emissions above regulatory limits observed for short time periods.

- July. Plant shuts down for modification of the wet cyclone. Additional spray nozzles added to increase the water flow rate.

- August. Agency determines that plant not subject to National Emissions Standards for Hazardous Air Pollutant Standards (asbestos).

1977 - September. Permit requested by Company.

- September. Routine inspection; plant only in marginal compliance based on visible emission levels.

- September. Special inspection; plant emissions unchanged.

- November. Neighbor complains of high dust fallout problems due to emissions from the plant.

- November. Plant reports that water line breakage during a period of high production required operation for 2 days without benefit of water spray in the wet cyclone.

1978 - July. Plant requests approval to modify cyclones. Spray nozzles added to second cyclone in order to improve efficiency.

- August. Modifications completed. Apparent initial compliance with emissions regulations.

3. Plant Description

Olivine ore is crushed, size segregated and dried at this plant for use in the steel industry. There are only two such plants in the country. The plant superintendent reports a steadily increasing demand for olivine (Mg_2Sio_4-Fe_2Sio_4).

The subject of the inspection was the rotary kiln drier, the principal source of particulate emissions at the plant. The kiln has a rated capacity of 20 tons per hour of 325 mesh olivine sand. At the rated natural gas firing rate, the volumetric flow rate is about 20,000 Acfm (200°F). The uncontrolled particulate emission rates have been estimated several times by the agency with the calculated values ranging from 420 to 900 pounds per hour. We suspect that the lower value is more accurate. The allowable particulate emission rate is 30.5 pounds per hour. Control efficiencies required to achieve compliance could vary from 93% to 97% depending on the actual mass loading to the control equipment. These efficiencies are well above the generally reported capability of large diameter cyclones. Continuous compliance could be expected only if the particulate mass median diameter is quite large or if the operating characteristics of the cyclones are quite unusual. We were unable to locate any particulate size distribution data applicable to olivine dryers in general or to this source in particular.

During the first year of cyclone operation, there were at least three incidents of opacity violations reported by the agency inspector. The cyclones were subsequently modified and no further opacity violations have been observed. Although the permit includes the malfunction reporting stipulation, the plant superintendent did not call the agency during the one documented malfunction. The permit also includes an operation/maintenance recordkeeping stipulation which has not been envoked.

The plant is located in a steep mountain valley probably having poor meteorological dispersion characteristics. There are several residences within 300 to 1000 feet of the stack, but the population density in the general area is quite low. Only one citizen complaint is recorded in the files during the two years that the cyclones have been in operation.

Anthophyllite asbestos has been identified in the Olivine ore. The plant superintendent suggested that the levels of asbestos were quite low, but he could not provide a quantitative analysis. It is somewhat disturbing that the State files also lacked any quantitative data on prevailing asbestos contamination in the ore and on the distribution of this asbestos in the collected particulate or in the treated gas. This plant is not subject to the National Emission Standards for Hazardous Air Pollutants (NESHAPS).

This plant was chosen for study because it has been reported that cyclones suffered serious deterioration shortly after installation. As indicated in the next section, we did not observe any corrosion or erosion problems which indicate any significant operating problems.

4. Design Evaluation

The rotary drier control system consists of two company designed, locally fabricated, wetted wall enter the first cyclone around the center of the cylinder. Due to the tangential flow, a portion of the entrained particulate matter is collected in the water layer on the shell and this material is ultimately removed in a slurry form at the cyclone sump. The partially treated gas is removed vertically and is again directed through a very narrow inlet duct. The high gas velocities obtained in this tangential inlet duct result in some additional particulate collection on the wetted walls of the second unit. Slurry removal is done in an analogous fashion. While the outer physical dimensions of these cyclones are identical, it should be noted that the internal design is significantly different. Due to the long outlet extension of cyclone 2, it should be much less susceptible to gas shortcircuiting than the first unit. Due partially to the unusual design of the two units and partially to the lack of particle size data, it is impossible to use standard engineering equations in evaluating performance.

In the original design, only the second cyclone was equipped with water spray nozzles. After less than a year's operation, the plant management decided to increase the water flow rate to this unit and to add a similar number of spray nozzles to the first cyclone. These modifications were completed less than 3 months ago.

At the reported gas flow rates, extremely high inlet gas velocities should result. Our calculations suggest that velocities of 220 feet per second could be reached at the cyclone inlet. The company permit application listed a value of 140 feet per second. In any case the inlet velocity is more than 3 times the general design level of 50 feet per second (20 to 70 feet per second is the common range). At this high velocity, particle collection, particularly in the small diameter range of 5 to 20 microns, should be much better than for most large diameter cyclones. Unfortunately, this velocity should also result in rapid erosion of the inlet duct work and possibly the cyclone shells in the vicinity of the inlet. The water layer may alleviate this erosion to a certain extent in the lower sections of the cyclones. The high inlet velocities also account for the very high pressure drop of 7 inches H_2O (normal range of 0.5 to 2.0 inches) reported in the initial permit. Pressure drop is generally proportional to the square of the inlet velocity.

The layout of the equipment is not conducive to routine maintenance. Access to the nozzles can be obtained only by crawling down a fairly tight annular space between the outer wall and the exit tube. It is very unlikely that the nozzles are checked on a regular basis and it is possible that these nozzles have not been changed since the cyclones were constructed. The plant superintendent was not aware of the present condition of the nozzles.

The water is distributed to the cyclones via polypropylene 1" and ½" lines. Unless the operators are very careful to drain the lines every time the cyclones are shut down it is probable that some freeze-up occurs. During winter operation there may be some temptation to operate the units without water in order to avoid time consuming thawing of lines. We have no reason to suspect that this has in fact occurred.

We observed a large accumulation of sludge around the mouth of the 50' stack. It must be presumed that there is some entrainment of water droplets through the I.D. fan and up the stack. This could lead to frequent fan imbalance which would require shut-down of the entire process.

The control system was completely devoid of monitoring instruments. This type of system should at a minimum include one manometer to record total system pressure drop and a water meter to monitor the recirculation rate. Without this equipment it is practically impossible for the operator to confirm normal operation and to insure compliance. Due to the water vapor content of the exit stream, opacity should be obscured during most cold weather periods.

The internal inspection of the cyclones revealed that of corrosion on the outer shell, which we had originally anticipated due to the CO_2 levels. Either there has not been sufficient time for the units to corrode or the olivine dust has alkaline properties which keeps the pH above 6. There was also no evidence of erosion on the limited portion of the internal surface which we could see. It was impractical to inspect the inlet ductwork where erosion is most likely.

At the reported collection rate of more than 400 pounds per hour, the slurry going to the settling pond would be 10 to 14% by weight solids. It would require a sludge pump to transport this material and no such pump was on site. We were also unable to identify any sluice line to aid in the transport of this material.

5. Performance Evaluation

5.1 Preventive Maintenance Program

There is no preventive maintenance program. Repair and clean-up of the system is done on an as-needed basis only. Fortunately, the system is relatively simple and malfunctions should be rare even without proper maintenance practices.

5.2 Recordkeeping

There is no control system performance data due to the lack of any monitoring instruments. Maintenance records are either not taken or are discarded. The present plant manager has been at the plant only two months and is not aware of any previous records concerning the cyclones.

5.3 Emissions

A stack test will be performed by the agency in early 1979. This test has been delayed several times at the request of the company. No quantitative data is available. Since the plant manager is new and the files are somewhat incomplete, there is no accurate data with which to estimate emission rates.

Due to this lack of data and the inapplicability of theoretical models to this very unusual "homemade" scrubber, the annual average emissions profile of Figure 1 is highly speculative. Reasonable collection efficiency should occur based on the high inlet gas velocities. However, several modifications have been necessary to remain in compliance with visible emission limitations. For these reasons we estimate emissions to be close to the required mass emission limitations. Following the increase in water flow rate and the addition of spray nozzles to the second cyclone; we estimate emissions are now in compliance.

The excess emissions projected in this case are rather small. We do not believe that the agency could have prevented initial noncompliance, since the company deserved an opportunity to demonstrate that their econ-omical system could comply. We do believe that a stack test was justified after start-up of the scrubber in 1976. This test would probably indicated noncompliance with mass emission limitations and thereby resulted in more expeditious modifications to the system. Accordingly, we estimate 75% of the excess emissions could have been prevented by more aggressive monitoring on the part of the agency.

5.4 Spare Parts Inventory

The source does not stock any spare parts for the wetted wall cyclones. It is their position that all of the necessary equipment is locally available.

6. Costs

The reported installed costs of the cyclone system is only $4,500. In our opinion, this cost is too low even considering that the unit was designed in-house and fabricated locally. The plant superintendent did not have any cost data specific to the cyclones. The operation and maintenance costs are limited to the energy cost of the fan.

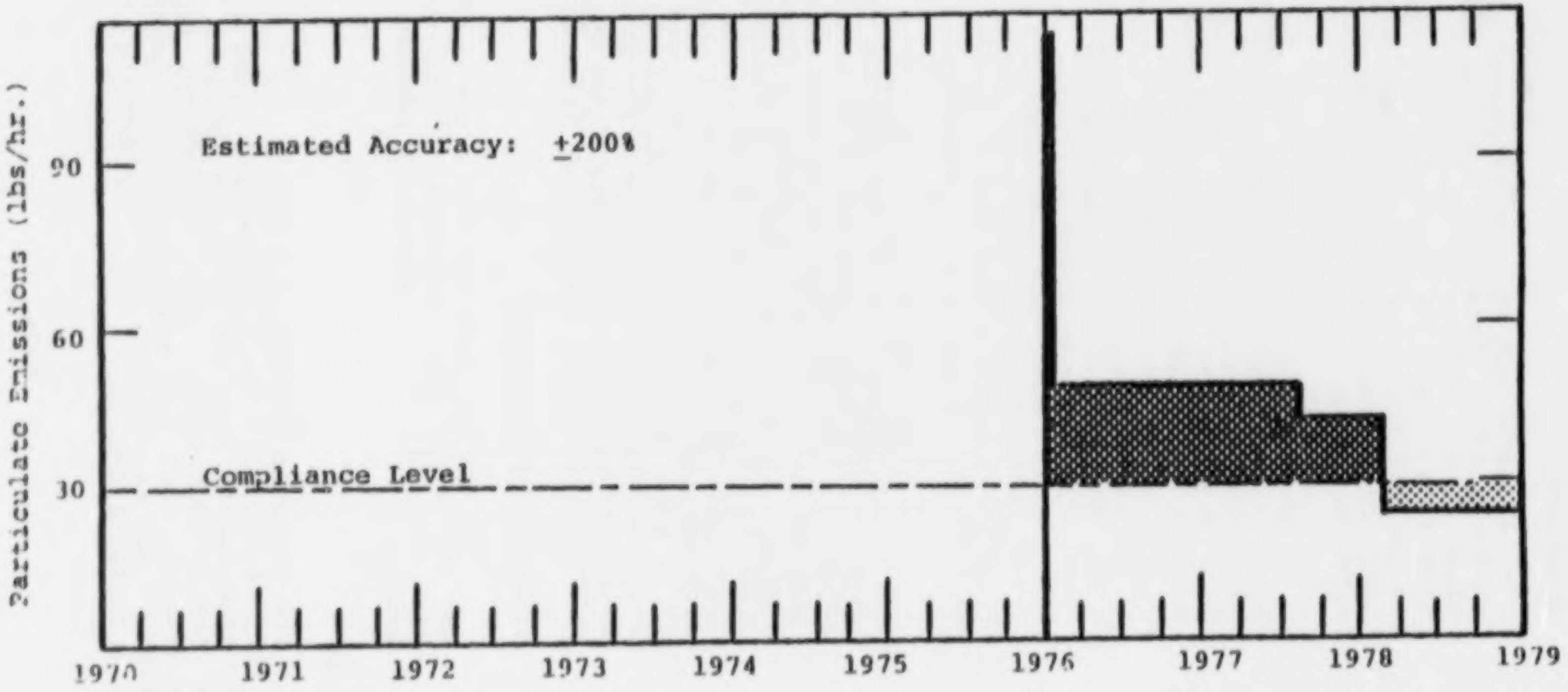


Figure 1. Estimated Emission Rate for Source 9.

INSPECTION REPORT

Source 10

1. Summary of Visit

The plant solvent vapor recovery system was inspected in September 1978. From information gathered during the visit it appeared that the equipment is kept in good working order. The plant engineer estimated that recovery efficiency of the system exceeded 90% of uncontrolled emissions, although he did not allow a review of his solvent recovery records. (An 85% reduction in vapors is required by State regulations.)

A significant finding during the visit was that State inspectors rarely, if ever, review the records of solvent recovery. Another finding during the visit was that the State's review of the permit application may have been too superficial. The plant engineer indicated that some of the solvent used was collected as liquid waste, but there is no evidence to indicate that the State verified this. Should any portion of these liquid wastes vaporize before collection, they could represent air emissions that are not accounted for in the recovery calculations.

2. Chronology of Source/Agency Interaction

1972 - August. Source applies for a temporary permit to emit particulates and hydrocarbons.

- December. State issues temporary permit.

1973 - 1975. Design difficulties encountered. Source contacts consultants and vendors for opinions. Condensation vapor recovery and solvent vapor incineration found to be prohibitively expen sive. Scrubber systems not feasible because of water pollution problems.

1974 - January. Temporary permit extended for one year.

1975 - January. Temporary permit extended for another six months.

- May. Source procastinates on selecting and installing control system. State requests proof that a good faith effort is being made. State later has source sign a Special Order of Consent agreement.

1976 - April. Carbon bed adsorbers installed and placed in service. Apparent initial compliance with emissions regulations.

- June. Source applies for a permit to operate the carbon bed adsorbers and control equipment for other plant processes. Difficulties with the latter delay the issuance of the permit.

- September. Visual inspection finds plant in compliance.

1977 - July. Visual inspection finds plant in compliance.

1978 - January. Application for a permit to operate the carbon adsorbtion beds is re-submitted.

- April. Permit is issued.

3. Plant Description

This source is a textile finishing plant that emits hydrocarbon solvent vapors. Fabric is coated with a latex material and dried in ovens. The solvent vapors generated during drying are collected and directed to three activated carbon solvent recovery units. The stack for the solvent recovery units is located approximately 500 feet from the nearest residence. However, more than 30 houses are within 1,000 feet of the stack.

The latex coating operation uses toluene as the solvent, and is subject to State regulations requiring 85% control. Of six drying ovens, only three to four are operated at one time. The vapor-laden air from the ovens is exhausted to three carbon adsorption beds for recovery (see attached Figure 1). The recovery system is designed so that two beds are adsorbing while the third bed is being regenerated. Timing of the adsorb-regeneration cycles can be controlled by three methods: manually, by timer or by a stack monitoring device. The stack monitoring control device is designed to switch an adsorption bed from the adsorb mode to the regeneration mode when exhaust stream solvent concentration reaches a predetermined level. The plant engineer could not recall the exact concentration the monitor was set for, but he felt certain it was less than 100 ppm toluene. The system was initially operated by this monitor, but experience with this mode of

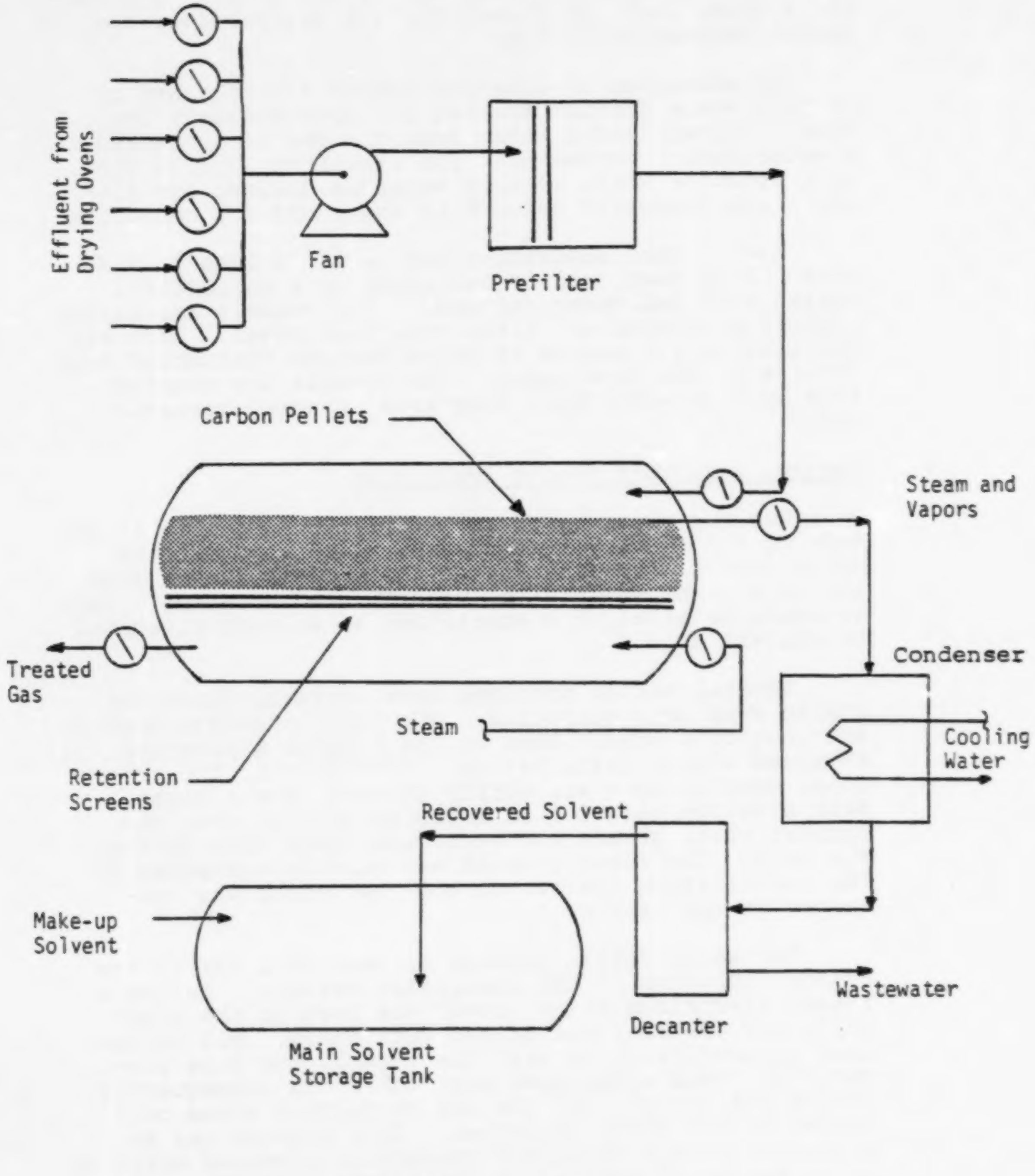

Effluent from Drying Ovens
Fan
Prefilter
Carbon Pellets
Steam and Vapors
Treated Gas
Condenser
Steam
Cooling Water
Retention Screens
Recovered Solvent
Make-up Solvent
Wastewater
Decanter
Main Solvent Storage Tank

Figure 1. Process Flow Diagram for Source 10.

operation has permitted the use of the timer. Typically, a carbon bed can adsorb for 4-8 hours before the carbon becomes saturated.

Regeneration of a carbon bed is accomplished by passing steam through the bed for approximately one hour. Solvent-laden steam from the bed is condensed in a water-cooled condenser. The resulting liquids flow to a decanter where settled water is drained for disposal and recovered toluene is drawn off for recycling.

Each carbon adsorption bed is 17 ft long × 19 ft wide × 2 ft deep, and is contained in a cylindrical vessel with hemispherical ends. The vessels and carbon retention screens are 316-L stainless steel. Each bed contains 12,000 pounds of Union Carbide "Columbia" type JXC-4-6 carbon (4-6 mesh). The Vessels are mounted side by side with their long axes oriented horizontally.

4. Control Equipment Design Evaluation

Maximum capacity of the adsorption units is 30,000 acfm at 200°F. According to the plant engineer the units remove more than 90% of the toluene vapors from the dryer exhaust streams, under present loading. This estimate is based on a comparison of solvent purchased to solvent used.

Several design problems have surfaced since the system went into operation. The first problems were in the control system. Some of the control piping was reversed during installation. In addition, the original control unit air supply did not have a dryer. Both problems resulted in improper control over the dampers which govern the vapor and steam flow through the beds. The first problem was quickly corrected by the installation contractor and the second was corrected by the vendor.

The major design problem evident thus far is the outdoor location of the adsorption vessels. During a recent electrical storm, power was lost to the plant while one adsorber was filled with steam. All valves shut automatically to seal the vessels for fire prevention. Rain associated with the storm subsequently cooled the vessels and the one containing steam collapsed as the steam condensed. This problem can be mitigated by enclosing the vessels in a heated building or it can be eliminated by installing vacuum breakers. The latter option, however, could present a fire hazard during certain situations. It is worth noting that the damaged vessel is being replaced from insurance coverage rather than by the vendor. The plant engineer said that the system had sufficient capacity with two vessels to meet State regulations.

Another problem encountered during the first two years of operation of the solvent recovery system was a slight corrosion problem in the steam condensate pipe. Thus far there has not been a significant corrosion problem within the vessel such as occurred at Source No. 12

5. Performance Evaluation

5.1 Preventive Maintenance Program

During the first two years of operation, no formal preventive maintenance program had been established for the carbon adsorption units. Their operation has been nearly trouble free, except for the failure caused by the loss of electrical power. The preventive maintenance program consists of daily visual inspections of the control panel indicator lights and temperature gauges and of the exterior of the equipment.

5.2 Recordkeeping

Recordkeeping for the plant solvent recovery system is minimal at this time. There are no provisions in the system for measurement of regenerative steam use, overall air flow rate or toluene concentration in the stack effluent. In addition, the stack has been constructed with a sharp elbow near its terminus, a design which makes stack sampling by field apparatus very difficult. There are provisions for measuring pressure drop across the beds, but this is not regularly recorded. The only system parameter regularly recorded is the toluene recovered. The plant engineer indicated that the amount of solvent in the recovery storage tank is regularly measured by reading a float gauge. Emissions are deduced from these measurements, although the plant engineer was reluctant to produce a tabulation of these data.

5.3 Emissions

Before installation of the toluene recovery system, the source was emitting toluene vapor up to an estimated maximum rate of less than 1400 lbs/hr. The system is now designed to reduce these emissions by at least 86%. The source estimated from measurements of recovered toluene that monthly emissions are less than 10% of former emissions. The recovery system has provided service for all but two days since its start-up. Thus far there has been no discernible decrease in the efficiency of the system. Recovery efficiency has varied no more than 2% on a monthly basis.

5.4 Spare Parts Inventory

The source has found it unnecessary to maintain a large reserve of spare parts for its solvent recovery system. Major components such as charcoal, the blower and the timer are not kept in stock. Several minor parts such as damper gaskets, indicator lights and pre-filters are kept in stock, but the plant engineer indicated that these items are inconsequential with respect to the initial cost of the system.

5.5 Other Comments

The State agency's determination of the emission reduction due to the solvent recovery system may be too superficial. The source recovers less than 70% of the toluene used in its operation. The reduction in airborne emissions is described by the source as being greater than 90%. The source claims that 25 to 30% of toluene used is lost as liquid waste. There is little evidence that the agency verified the accuracy of these figures during review of the source's permit application. Likewise there is little evidence that the agency has attempted to determine if the liquid wastes generate fugitive vapor emissions. Finally, the State has not performed any "before and after" stack tests.

6. Costs

The toal purchase cost of the carbon bed adsorbers was approximately $600,000 (1976 dollars). Records of annual operating costs have not been maintained. There are no records of electrical power consumption or steam used. Discussions with the plant electrician revealed that labor devoted to inspection and maintenance is probably less than 25 hours each month. The plant engineer felt that the initial expenditure for installation of the system would be recovered in 2 to 4 years by the reductions in solvent use.

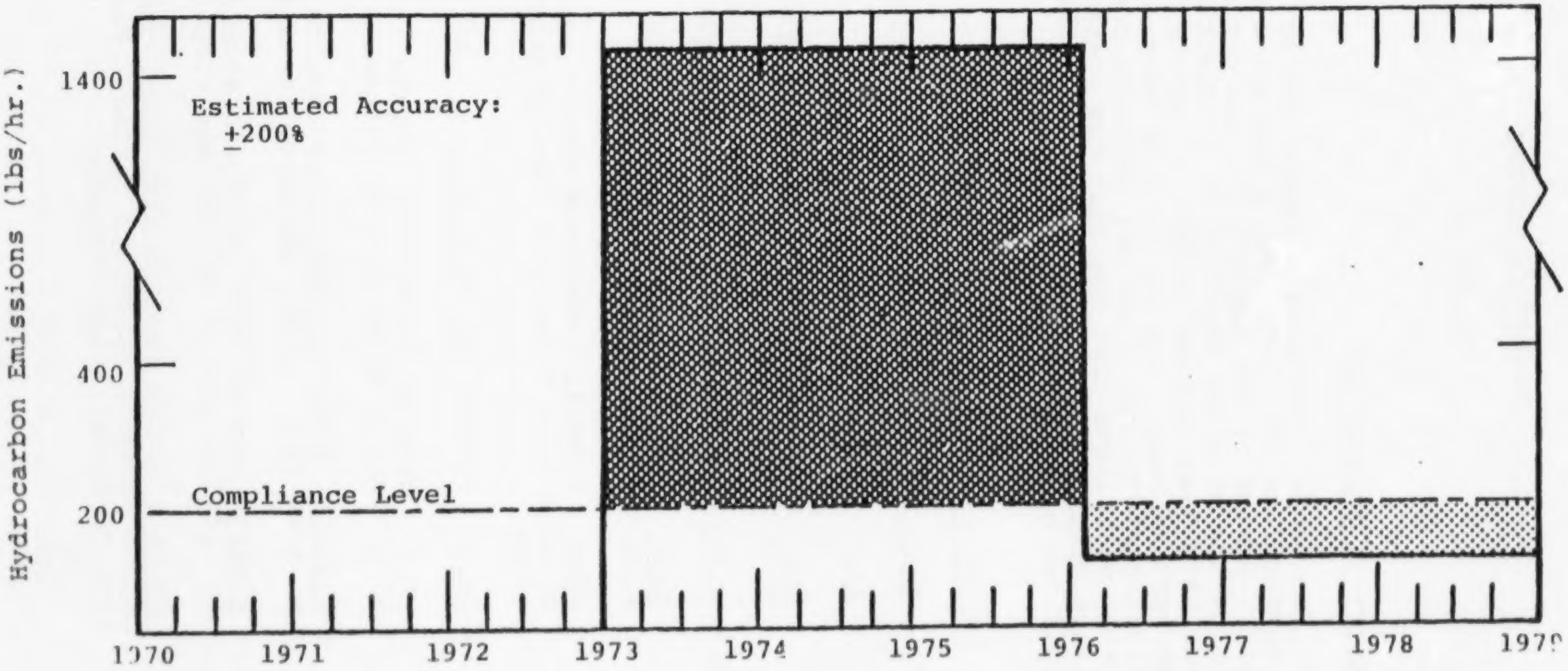


Figure 1. Estimated Hydrocarbon Emissions Rate for Source 10.

INSPECTION REPORT

Source 11

1. Summary of Inspection

The Company operates a fabric filter for control of particulate emissions from a hot mix asphalt batch plant. Damage to the support collars during installation of the unit has resulted in frequent bag tears. These have been repaired either by patching or by replacement of bags. Due to the wide margin between typical performance levels and required compliance levels, we believe that the unit has operated in compliance despite the bag tear problems. The agency has maintained close and effective surveillance of this plant.

2. Chronology of Source/Agency Interaction

1977 - January. Permit requested by Company.

- May. Permit approved by State.
- May. Plant start-up. Apparent initial compliance with regulations.

1978 - April. Plant requests permit approval.

- May. Routine inspection; source in compliance with visible emission regulations.
- June. Special inspection (two); source in compliance both times with visible emission regulations.
- July. Ambient air violation noted.
- July. Special inspection; source in compliance with visible emission regulations.
- August. Special inspections; source in compliance with visible emission regulations.
- August. Agency sent letter to source asking for explanation of ambient air violation.
- August. Source replies that auger failure required manual cleanout of system. Fugitive dust from cleanout caused violation.

3. Plant Description

The plant consists of an oil-fired rotary dryer, an aggregate gradation control unit, a pugmill for coating the aggregate with asphalt, and a baghouse for reducing the dust generated by this equipment (See Figure 1). The process begins when selected grades of crushed stone and sand are introduced into the dryer, counter-current to the oil burner exhaust. The aggregate is dried and heated and then transferred by conveyor to the aggregate gradation control unit above the pugmill. From there, a controlled distribution of hot aggregate is passed down into the pugmill where it is coated with asphalt and loaded into trucks for transport. The baghouse handles particulates from the rotary dryer exhaust as well as particulates generated within the gradation control and pugmill enclosure. Dust generated in the conveyor systems is contained by conveyor enclosures. Fugitive dust generated by the plant truck traffic is controlled by water spray.

The plant is located within 500 ft. of 5 houses with the closest of these being less than 300 ft. away. The proximity to these residences has resulted in several complaints to the State agency since it began production.

The location was selected by the source because it is near it's customers, because it is near the quarry that supplies its aggregate, and because it is convenient to the major highways in the region. Alternate locations were considered, but there were less acceptable as they were located in flood prone areas.

The current permit for the plant stipulates that the plant must shut down whenever any type of failure occurs in the air pollution control equipment. However, it seems unlikely that plant operators would be inclined to shut down in the middle of a batch, except for major failures. The control equipment has a sufficient factor of safety that minor failures, such as a single bag tear, may not necessarily exceed the State regulations. The plant can process over 100 ton/hr of asphalt mix. This production can generate about 7,000 lb/hr of dust. The baghouse is designed to control 99.9% of the dust, emitting less than 7 lb/hr. The State regulation limits emissions to 45.2 lb/hr. The source plans to operate the plant about 1,800 hours per year, producing approximately 50,000 tons of asphalt. Production was about half this amount during the first year of operation.

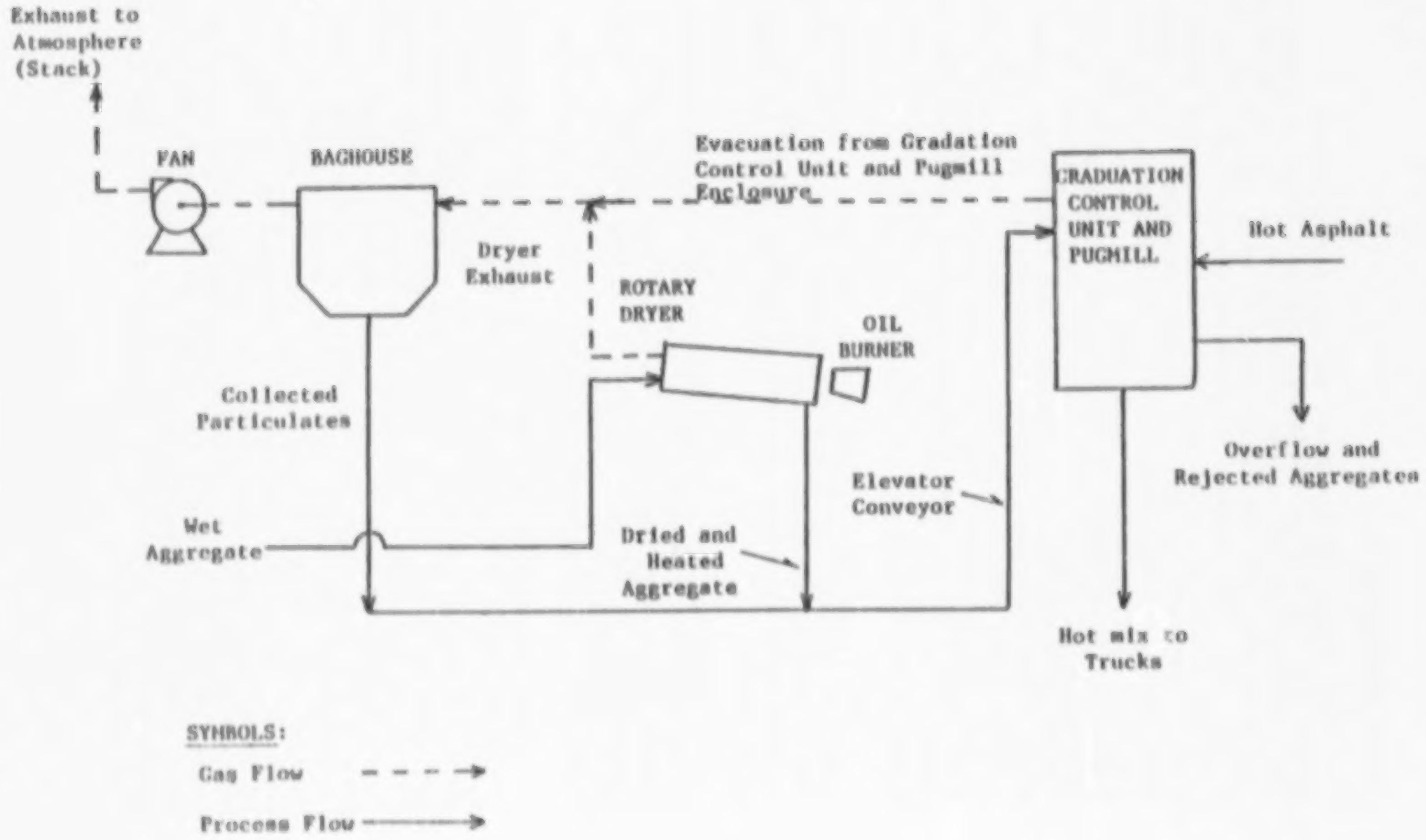

Exhaust to
Atmosphere
(Stack)
FAN
BAGHOUSE
Evacuation from Gradation
Control Unit and Pugmill
Enclosure
GRADUATION
CONTROL
UNIT AND
PUGMILL
Hot Asphalt
Dryer
Exhaust
ROTARY
DRYER
OIL
BURNER
Collected
Particulates
Overflow and
Rejected Aggregates
Elevator
Conveyor
Wet
Aggregate
Dried and
Heated
Aggregate
Hot mix to
Trucks
SYMBOLS:
Gas Flow
Process Flow

Figure 1. Process Flow Diagram for Source 11.

4. Control Equipment and Design Evaluation

Prior to the installation of the baghouse, the plant used a venturi scrubber for emission control. Plant personnel were quite satisfied with the scrubber, but were forced by Company policy to switch to a baghouse. The Company has apparently had problems at plants using scrubbers in other states and has decided to rely solely on baghouses in the future.

The baghouse has about 6,000 sq. ft. of cloth area and contains more than 300 felt bags arranged in rows of 12. Bags are cleaned by reverse pulse air jets generated by a 120 psig air supply. The baghouse has a maximum inlet/outlet pressure differential of 6 inches of water, and a maximum air-to-cloth ration of 5 to 1. The air flow is induced draft developed by a 200 hp fan.

The baghouse has presented two problems since the plant went into production. The first problem was caused by a broken V-belt for the baghouse dust auger. Large quantities of dust accumulated in the baghouse hopper before plant personnel discovered the failure. The plant lost several hours of production while the hopper was manually emptied. The unloading of the hopper released sufficient fugitive emissions to cause a nearby State agency ambient air sampler to record a violation for the region. Under normal conditions the hopper does not develop dust bridging, The hopper sides have an angle of inclination of about 60°.

A second problem with the baghouse has been frequent failure of the felt bags. Most bag failures appear to have resulted from damage incurred during the dismantling and reassembly of the baghouse when it was moved. Small tears have been temporarily patched with wads of felt material cemented over the tears using a silicon based putty. Bags are presently scheduled to be cleaned and permanently patched by a firm that regularly performs such work.

The plant control equipment appears to be well matched to the particulate distribution of the dryer exhaust and it is quite capable of achieving the mass-emission regulations. However, the system lacks several features which may lead to future operation and maintenance difficulties. The system does not have a primary collector device such as a cyclone, as do 86% of U. S. mobile batch asphalt plant.* Because of this, it is possible that abrasion by larger particulates might increase bag wear near the baghouse inlet. Operating personnel have already reported excessive wear at the baghouse inlet baffle. Another possible oversight is the lack of insulation for the baghouse. During cold weather the system may experience a condensation problem, causing bag blinding and corrosion. (Thus far the plant has not been operated much during the winter.)

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*Asphalt Industry Survey, Monsanto Research Corporation, Dayton, Ohio, November 12, 1975, p. 24.

Finally, several defective pulse-jet venturi nozzles were observed during our plant inspection. A significant percentage of the venturis were received from the manufacturer with flashing or burrs protruding into the throat at the casting mold parting-line. These imperfections should have been removed before delivery, because they might make the pulse cleaning operation less efficient.

5. Performance Evaluation

5.1 Preventive Maintenance Program

The source's preventive maintenance program consists of a weekly inspection of the control equipment. Most bag failures are pinpointed at this time by noting dust accumulations near the venturi exits at the top of the unit. Flourescent tracers are occasionally used to find less visible failures. Plant personnel indicated that maintenance of the control equipment requires an average of 8 man-hours per week although this has been highly variable due to the problem of damaged bags.

5.2 Recordkeeping

The source does not keep records of the operating parameters of the baghouse. The only parameter for which there are provisions for measurement is the inlet/outlet pressure differential. Operating personnel indicated that they read the manometer, but they do not record it. They reported that the typical reading is about 2 to 2½ inches of water although we measured 4½ inches during our visit. (Perhaps the operating personnel have neglected to double the reading, as is typically required with a manometer.) The source does keep a precise annual accounting of purchases of baghouse replacement parts.

5.3 Emissions

No stack test has yet been performed at the plant, so it is difficult to reconstruct a quantitative emissions profile. The State generally does not request a stack test for baghouses unless plume appearance is unsatisfactory. The Company guessed that the plant achieves compliance 90-95% of the time. We believe this to be a reasonable estimate in view of the plant's proximity to a State ambient air quality monitor. We believe that violations of emission regulations are typically the result of one or more bag failures occurring midway through a batch cycle. In this case, the control unit will operate with decreased removal efficiency until the plant shuts down at the end of the batch (usually less than 8 hours). The bags are then replaced before the next start-up. There is no reason to believe that the plant has ever continued operating after a major failure of the control system.

An annual average emissions profile (Figure 2) has been compiled based on the very limited data available. There are substantial time periods that the source is not operating. Typical emissions during periods when there are no serious uncontrolled bagleaks are estimated at 10 pounds per hour. We have arbitrarily added several peaks to indicate periods of non-optional performance. The actual times when these problems persisted are unknown since no records are kept.

The Agency surveillance of this facility appears to be effective. We do not believe that any additional Agency effort either through existing regulations or new regulations could be cost effective. The excess emissions estimated are very small and probably unavoidable without replacement of the supporting bag cage assemblies.

5.4 Spare Parts Inventory

The source maintains a control system spare parts inventory valued at approximately $3,000. This inventory includes:

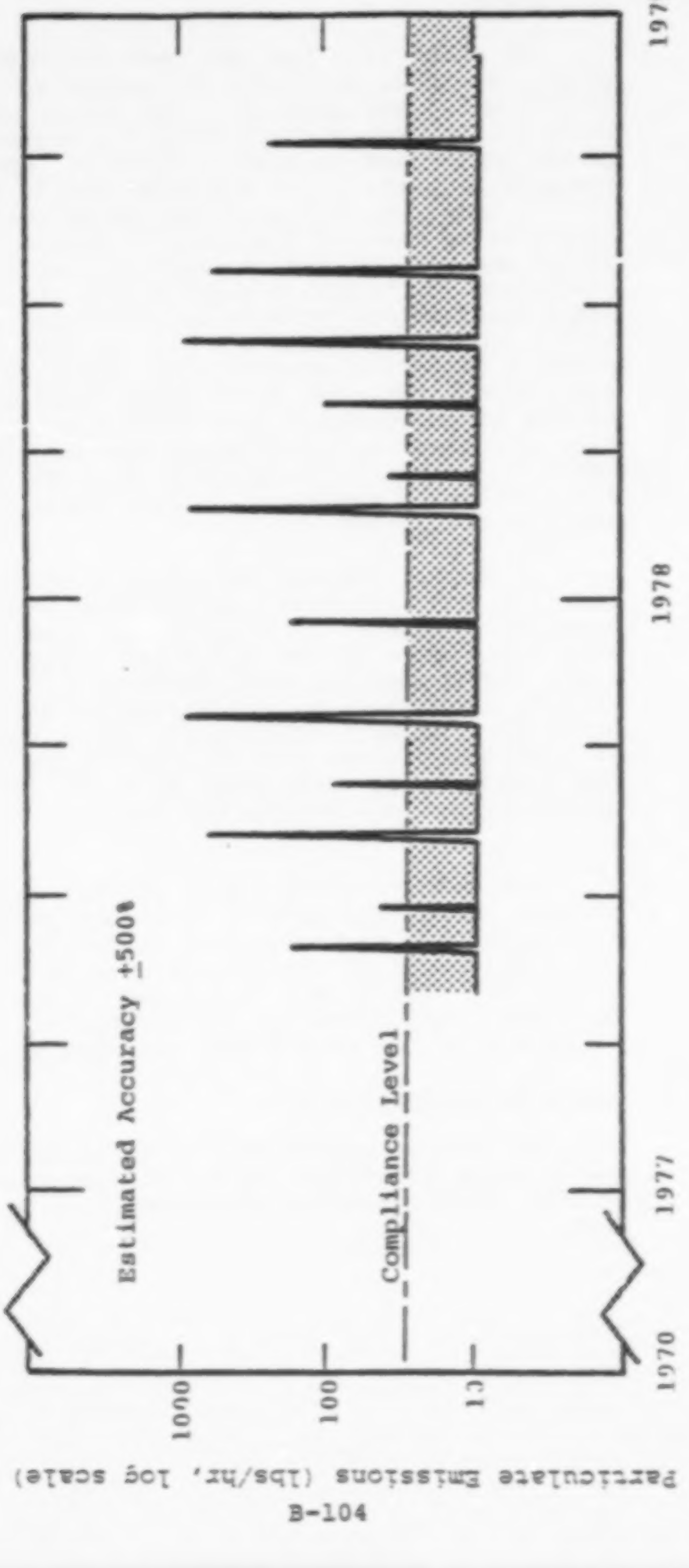


Figure 2. Estimated Particulate Emissions Rate for Source 11.

Item	Number	Notes
Bags	100	$14/each
Bag cages	50-100	
Pulsing solenoids	5-6	locally available
Fan bearings	2 sets	
Bag clamps	200	
Dust bin auger	1	
Auger bearings	1 set	

Lack of spare parts has apparently never caused a significant delay in returning the system to operation.

6. Costs

The delivery cost of the baghouse was about $85,000 and installation costs were about $6,000 (1977 dollars). A total of about $4,000 was spent during the first year for replacement of ripped bags. Labor devoted to the control equipment averaged 8 man-hours per week. (The plant was in operation for only part of the year.) Fan electric power usage is not metered. Collected particulates are recycled, which results in materials savings that partially defrays the costs of operation.

INSPECTION REPORT

Source 12

1. Summary of Visit

The carbon bed adsorption system has had chronic maintenance problems in the form of corrosion failures. These maintenance problems have undoubtedly resulted in occasional short term violations of the emission standards. The State has made two oversights in the issuing of the plant's permit. First, the State overlooked as much as 30% of the uncontrolled hydrocarbon emissions when reviewing the permit application. Later, the State overlooked a significant process change which should have warranted a permit review.

The plant has operated out of compliance on a continuous basis for approximately 20 months. The source does not view the high emissions as a violation due to misinterpretation of the regulations. The agency inspector is not aware of the excess emissions despite the fact that source records clearly indicate this violation. The excess emissions persisted despite the economic penalties of solvent loss. The plant manager reported that he has been too busy to direct attention to the necessary control equipment modification. With the exception of the vapor loading problem, the source has been extremely conscientous in the operation and maintenance of the carbon bed adsorbers.

2. Chronology of Source/Agency Interaction

1972 - October. Source applies for permit.

1973 - January. State issues temporary permit to discharge hydrocarbon solvents. Source plans to switch to non-photoreactive, exempt solvents.

- September. State issues permit to operate using exempt solvents.

1974 - Source reports that exempt solvents are not available in sufficient quantities. Source submits proposal to install and operate a solvent recovery system.

- October. Routine inspection; control equipment in operation. Apparent initial compliance with emissions regulations.

1975 - June. Routine inspection; State finds plant in compliance. Issues a permit for operation of the control equipment.

- September. Routine inspection; State finds plant in compliance.

- January. Source reports that corrosion has caused a major failure of the equipment. The State visited the source while repairs were in progress and found it to be in compliance due to the use of exempt solvents.

1976 - Plant was visited four times by the State and found to be in compliance each time.

1977 - Plant processes are changed; quantity of solvent use increases. This, plus the aging of the adsorbent, causes control efficiency to decrease. The Sate does not recognize this problem.

- December. Routine inspection; State finds plant in compliance.

1978 - Plant visited three times by the State and found to be in compliance each time.

- November. Carbon pellets replaced, marginal compliance re-established.

3. Plant Description

The company operates two printers. The raw materials processed include the unprinted paper rolls, inks and make-up solvent. As received, the printing ink has a significant quantity of solvent.

The company uses a solvent of 75% Toluol (toluene) and 25% hexane. This solvent is used in 95% of their work, during which time they are subject to a regulation requiring 85% control. The remainder of the time, they use an exempt (non-photochemically reactive) solvent.

The printing ink used in the presses is a blended product containing both recycled and virgin solvent. Since make-up solvent has a present cost of 65¢/gallon and vapor loading from the presses is .45 gallons/hr each, there is an economic incentive to recover the solvent. The plant superintendent estimated that roughly 50% recovery was necessary to offset annualized costs. Exhaust from solvent vaporization is combined into a common duct leading to a booster fan. Total gas flow of ~10,000 acfm at 170°F then enters a prefilter for removal of oils, dust and other substances which could damage the charcoal beds. The filter house also cools the effluent to the desired inlet temperature of 100°F (see attached process flowsheet in Figure 1).

The vapors are collected in 2' - 3' deep charcoal pellet beds (1/16", 1/2" long) mounted horizontally in the tubular tanks. After 1 - 2 hours on line, each unit is desorbed using steam. During this time, the inlet and outlet dampers are in the closed positions while steam is passed through the charcoal. The resulting steam/vapor mixture passes to a water cooled condenser. The condensate is separated in a series of small tanks. The recovered solvent is sent to the initial storage tanks. After GC analysis, it is determined what impurities may have entered and how much hexane and/or toluene must be added to achieve original solvent composition.

Desorption requires approximately 45 minutes which is followed by a 10 minute cooling cycle. One of three units in each set is desorbing at any one time. Frequency and length of each cycle is controlled by automatic timers.

The carbon bed adsorbers were originally installed to satisfy emission limitation regulations. The company had originally hoped to comply through the use of exempt solvents despite the process control problems inherent with these materials. When it became apparent that sufficient quantities of exempt solvent could not be obtained, the carbon beds were ordered.

During the first several years of operation, the adsorbers have suffered severe unexpected corrosion problems. The stainless steel retention screens shown in Figure 1 have rapidly weakened and collapsed causing loss of the carbon pellets and a 1 - 2 week downtime. Exempt solvents have reportedly been used during these periods. The company has retained a number of consultants in a future attempt to identify the corrosive agents. The company has also attempted several improvements for corrosion control and has finally decided to use titanium screens. Due to the high cost of this material ($100 per pound fabricated) the company generally consideres the material a "last resort". These screens have been in place for 14 months with no signs of impending failure. The stainless steel screens rarely survived more than 12 months.

The plant superintendent suggested that the repeated handling of the charcoal pellets has caused physical degradation. As a result, he feels they now have excessive pressure drop across the beds due to

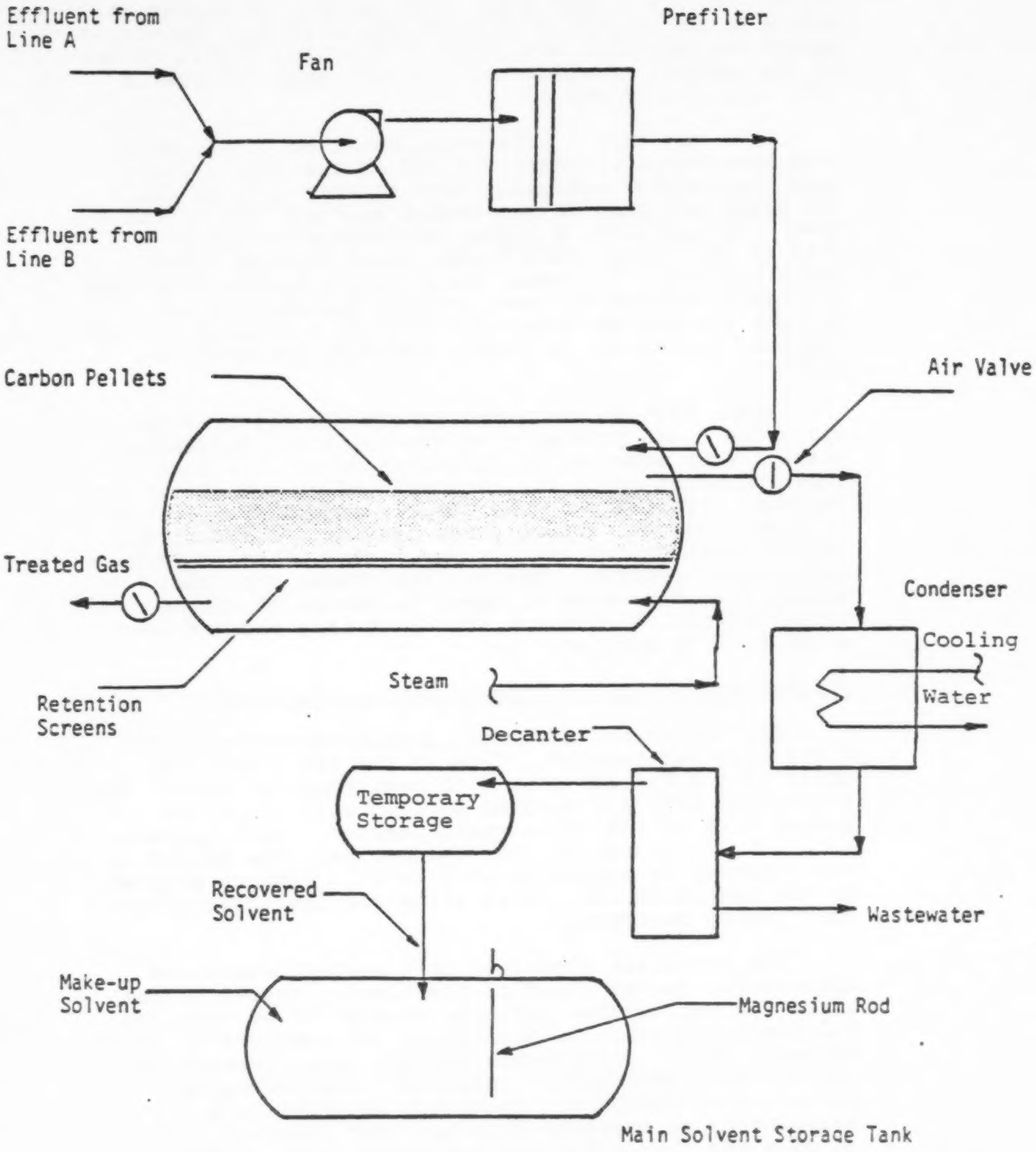

Effluent from Line A
Fan
Prefilter
Effluent from Line B
Carbon Pellets
Air Valve
Treated Gas
Condenser
Cooling Water
Steam
Retention Screens
Decanter
Temporary Storage
Recovered Solvent
Wastewater
Make-up Solvent
Magnesium Rod
Main Solvent Storage Tank

Figure 1. Process Flow Diagram for Source 12.

lower porosity, and have reduced adsorption area. We believe that this is somewhat less important than the "aging" of the carbon beds. The gradual reduction in active sites caused by the adsorption of high molecular weight contaminants generally reduces the effectiveness of the carbon. Average life in most applications is less than 2 to 3 years.

When the carbon beds were installed, the company used non-exempt solvents for 80% of the work. They have transferred equipment from another site so that the plant now handles non-exempt solvents 95% of the time. In addition, a higher percentage of the work load is for "solid color" jobs which produce higher vapor loading. The vapor loads on the carbon beds have increased because of these process changes. These changes are not recorded in the files maintained by the regional office and no permit revision has been requested.

There were no complaint reports in the file despite the close proximity of the plant to residential areas. When adsorber malfunctions occur, the plant superintendent calls the regional office and states the expected repair time. The company generally operates on exempt solvent during these periods. The regional office files do not contain any record of the telephone malfunction reports. Neither the company nor the agency read the dates of these telephone telephone conversations. We believe that this is a serious oversight by both parties.

4. Process and Control Equipment Design Evaluation

The carbon bed adsorbers handles approximately 3,300 acfm per reactor. Each of the six individual units is 6'O.D., 12' long with hemispherical ends. The adsorption beds are mounted horizontally along the center line of the cylindrical reactor. With approximately 3,500 pounds of charcoal per bed, the height of the charcoal is estimated at 2' - 3'. Dampers mounted on the gas inlet and outlet allow for isolation of the unit during desorption.

The units are installed in a heated, sheltered area on the second floor of the plant. Access to the units for maintenance purposes appears to be very good. All instrumentation is mounted on the reactors or on an adjacent wall. Instruments include vapor sensors on gas outlets, temperature indicators and recovered solvent flow monitors. There are no provisions for measurement of pressure drop or steam pressure. While we consider the latter two desirable, neither are essential to successful system performance.

As described previously, stainless steel corrosion has been a serious problem. While screens have presented the most immediate problem, the plant superintendent indicated that the reactor itself and most other components are experiencing corrosion. To correct some of the problems, they have started replacing all carbon steel lines between storage tanks. In the near future a lined 15,000 gallon tank will be installed to replace a 17 year old carbon steel tank. This old unit has been maintained only by use of cathodic protection, which consists of a magnesium rod anode immersed in the solvent and electrically connected with the tank shell. These rods have been replaced on a semi-annual basis.

These carbon bed adsorbers are one of the first such applications in the industry, therefore, certain design errors occurred. The cooling tower used to supply the condenser was undersized by a factor of 2. Separator vessels used for recovery of solvent from the steam/vapor condensate were also undersized. Plastic lines containing pressured air have suffered frequent cracking. We believe that only the latter problem has resulted in temporary noncompliance and in this case repairs were reportedly made within 24 hours.

The most serious problem appears to be the undercapacity of the present system. With the increased use of non-exempt solvents at this plant during the last several years and aging of the charcoal, the beds are no longer adequate to maintain compliance with a regulation requiring 85% removal efficiency. The installation of additional units should be considered.

5. Performance Evaluation

5.1 Preventive Maintenance Program

Under the direction of the plant superintendent, a regular maintenance program is performed. The unit is checked visually by an operator at least once per shift (2 - 3 shifts per day). On a weekly basis the solenoids and gaskets are checked since these components have the highest rate of failure. The performance of all moving parts is checked in detail during a monthly or bi-monthly inspection. The prefilter which serves to protect the beds is changed during the monthly/bi-monthly check. We believe that the preventive maintenance program at this plant is well conceived and implemented.

5.2 Recordkeeping

The amount of solvent recovered per day is recorded on temporary records for the plant superintendent. On a monthly basis the total solvent recovery quantities are measured by checking tank levels (dipstick) and virgin solvent addition quantities. These monthly records are kept on file for the regional office. The plant superintendent was unable to show these records during our visit since the file had been sent to the main plant for use in analyzing the performance of the carbon beds. These records are more than adequate for operating the system and ensuring compliance.

5.3 Emissions

There had been gradual deterioration in control performance due partly to the increased use of non-exempt solvents (overloading) and partly to the deterioration of the charcoal beds. A very approximate profile is shown in Figure 2 based on the material balance calculations of the plant superintendent. It is apparent that the unit has been continuously noncompliant for the past 20 months. In addition, there are short duration malfunctions caused by plastic line failure, gasket leakage and other mechanical problems which can result in the 1 to 2 week outage of a bed. These short term problems occur once or twice a year and cause efficiency to be in the range of 50 - 60%. Neither the source or the agency maintains records on the frequency of these problems.

A diurnal profile for a typical period after compliance has been re-established is shown in Figure 3. The saw tooth pattern results from the cycling of the 3 beds on a 3 hour cycle.

The company is planning to replace all the charcoal pellets to improve recovery efficiency. This change will probably provide for compliance and correct the presently uneconomical solvent loss. The source expects to recover 20 - 30 gallons per hour over the present rate.

All of the plastic lines are presently being replaced with copper tubing. This should help reduce the frequency of short term outages. While these modifications will probably achieve compliance, 1 or more additional beds may be needed to ensure adequate long term performance. With this addition it may be possible to shorten the

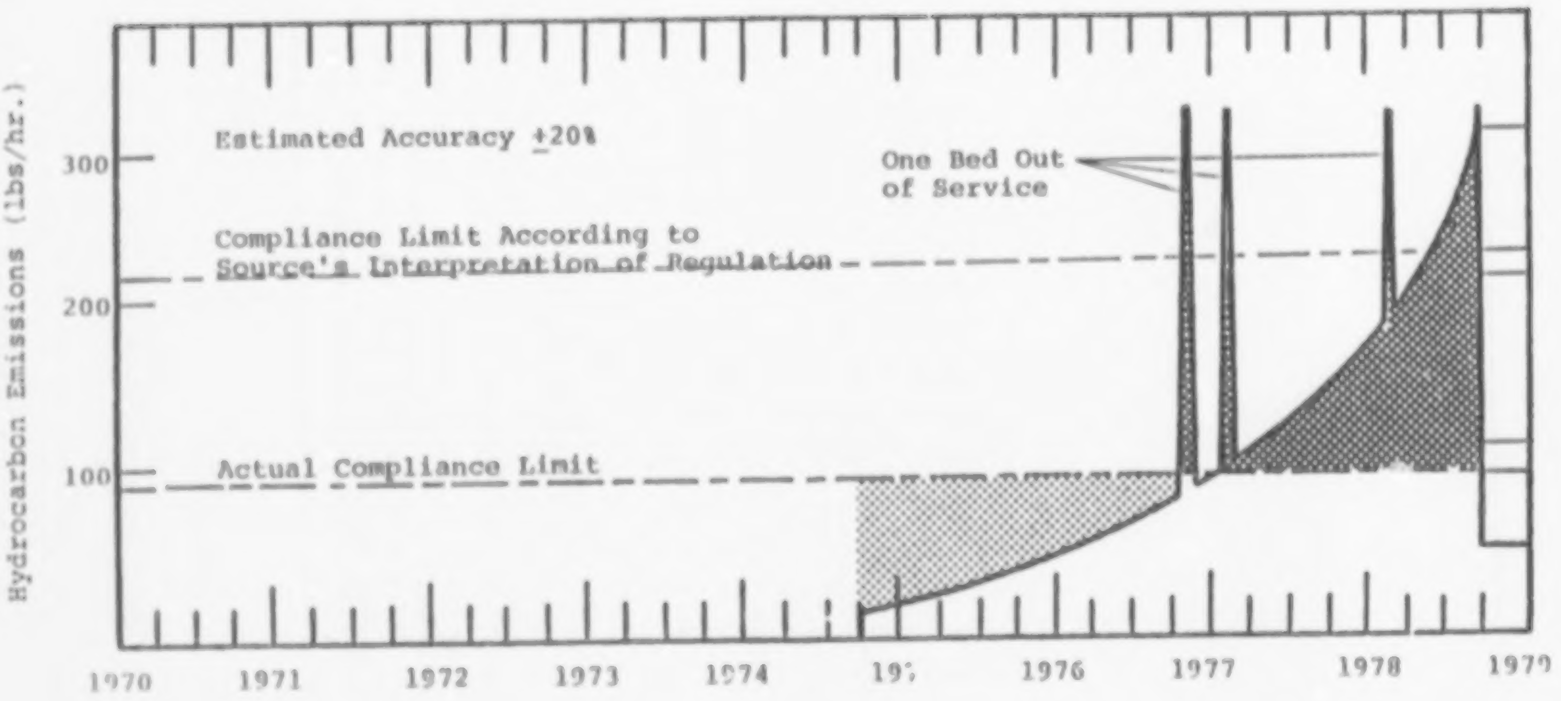
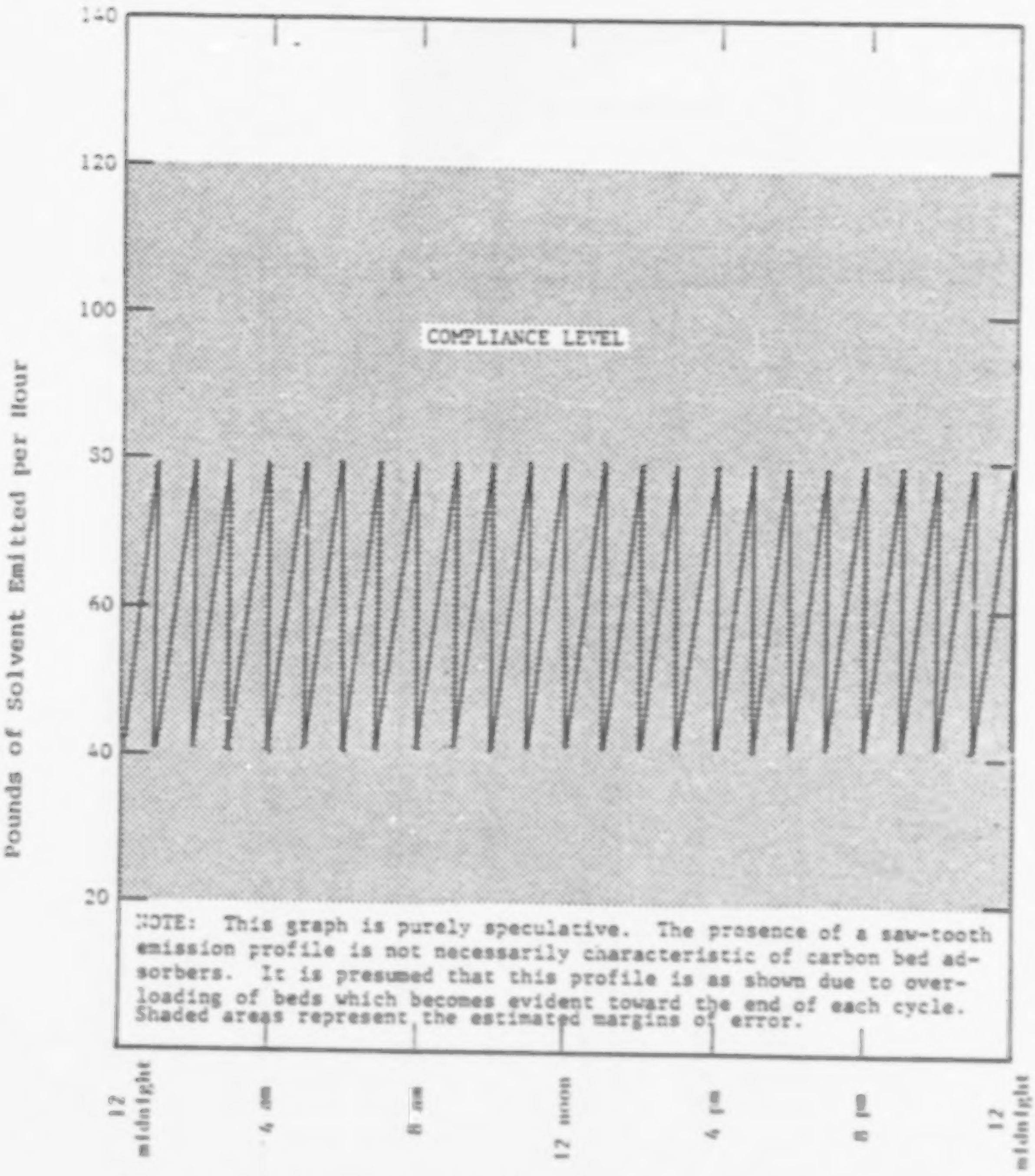


Figure 2. Estimated Hydrocarbon Emissions for Source 12.



NOTE: This graph is purely speculative. The presence of a saw-tooth emission profile is not necessarily characteristic of carbon bed adsorbers. It is presumed that this profile is as shown due to overloading of beds which becomes evident toward the end of each cycle. Shaded areas represent the estimated margins of error.

Figure 3. Estimated Diurnal Emissions Rate for Source 12.

time period between desorption. Also, the system would be less vulnerable to occasional bed outages. The company is investigating this option.

5.4 Spare Parts Inventory

The list of spare parts for the 6 carbon bed adsorbers is provided below:

Item	Number	Approximate Costs
Damper gaskets	2	$15.00 each
Timer clock	1	$500.00 each
Indicator lights	many	$150.00 total
Reset timer	1	$150.00 each
Relays	several	unknown
Timers	several	unknown
Solenoids	several	unknown

We believe that this list of spare parts is adequate for this particular application and geographical location. Delivery time for parts from the manufacturer ranges from 1 day (air freight delivery) to 2 weeks.

5.5 Other Comments

It appears that the company conscientiously operates and maintains the control system due both to control requirements and economic interests. Performance over the last year has been sub-standard; however, corrective action has recently been completed. Such steps were taken on the initiative of the source. It should be noted that these actions were delayed by more pressing process problems, thus, in this case economic inventions alone were not sufficient.

One unsolved question remains. The company has reported solvent recovery efficiencies of up to 130%. This is possible since the inks received at the plant already contained a certain amount of the solvent. It is our opinion that the regulation control requirement of 85% should apply to both ink and virgin solvent. Under this interpretation, the plant would have been in noncompliance for several years. There is nothing in the agency files to suggest that it is aware of the problem.

6. Costs

The total purchase cost of the carbon bed adsorbers was approximately $850,000 (1974 dollars). Installation plus ductwork, storage tanks and related costs totaled $650,000.

Annual operating costs include $3,600 for maintenance labor and supplies, minor electrical costs, and an unknown steam cost. The plant superintendent believes that steam costs are the highest component in annual costs, but he cannot separate plant steam use and carbon bed steam use. The total operating costs should be considerably higher than the partial sum of $3,600.

INSPECTION REPORT

Source 13

1. Summary of Visit

The Source has employed the use of positive corona electrostatic precipitators to control hydrocarbon emissions of the tenter frames of a textile plant. There are some design and application problems with the electrostatic precipitators at this plant. The Company has had more serious problems occur at other plants equipped with similarly designed ESPs. No operation or maintenance logs were kept by Plant management although detailed cost data were available. A moderate level of preventive maintenance is performed.

2. Chronology of Source/Agency Interaction

1972 - November. Agency performs compliance evaluation; visible emissions from tenter frames between 55% and 75% opacity.

1973 - May. Agency performs compliance evaluation; opacity exceeds 60%.

- June. Source applies for temporary operating permit.

1974 - September. Source applies for permit to operate boil-off washers.

- November. Agency contacts Source concerning plans to control tenter frame; Special Order of Compliance (SOC) necessary.

- December Agency grants permit for boil-off washers.

1975 - August. Source applies for permit to construct and operate new tenter frame to be controlled by a small electrostatic precipitator. Apparent initial compliance with mass emissions regulations.

- November. Agency grants permit for new tenter frame.

1976 - February. Routine inspection; high winds prevent visible emissions evaluation. Source applies for permit to construct and operate electrostatic precipitators on two existing tenter frames.

- March. Source applies for permits to construct and operate electrostatic precipitators on remaining existing tenter frames.
- April. Agency grants all permits for electrostatic precipitators. SOC to be modified to reflect the addition and time schedule for construction of the control equipment.
- August. SOC inspection; ESP on new tenter frame operational and in compliance with opacity limitations. Other units under construction.

1977 - November. Agency performs engineering evaluation. Two ESPs under construction. Two operating in compliance with opacity limitations. One ESP failure due to excess vibration; parts are on order.

- December. Source applies for permit renewal for boil-off washers and documents chemicals used are nonphotochemically reactive.

1978 - March. SOC inspection; replacement parts received for ESP that failed. Unit was off--line for three months and now returned to service. Opacity was generally 20% during this time but occasionally above 40%.

- June. SOC inspection; construction on all ESPs completed. All but two operational. Two units experiencing heat exchange problems.
- August. Routine inspection; all units operational and in compliance with opacity limitations. Opacity is less than 5%.
- September. Source notifies Agency that ESP that had failure before is being by-passed because of corrosion and blockage of ESP. Source correcting problem and no notice of violation is issued.

3. Plant Description

This finishing plant is part of the Company's extensive network of textile mills across the state. This particular plant is a textile finishing plant where various cloth materials are received to be washed and heat-set before leaving the plant.

The two-stage positive corona ESP units control the emissions from the tenter frames used for head-setting of the cloth material. The cloth, as received, contains a considerable amount of oil (similar to mineral oil) which was used to lubricate the knitting needles during the knitting process. This oil is removed by water washing and passing the cloth through the tenter frame (see Figure 1).

Heat to dry and set ("finish") the material is supplied by combustion of natural gas or LPG (depending upon the fuel supply situation). The material is "suspended" in the frame by supplying the heated air from both above and below the material. The material is allowed to cool gradually as it progresses towards the frame exit.

A majority of the oil left in the cloth after washing is driven off near the entrance of the frame. The temperature of the gas leaving the frame and entering the ductwork to the control device is between 350°F and 375°F. The temperature of the gas cannot be allowed to go too high or there will be damage to the cloth.

The gas is passed through a heat exchange prior to entrance into the two-stage ESP. The heat exchanger serves several purposes. First, it reduces the temperature of the effluent gas to the operating range of the ESP; second, it condenses the oils and fatty acids so that they may be captured by the ESP units; and third, it preheats the air supplied to the frame to reduce natual gas consumption. Each ESP unit has its own heat exchanger in the ductwork prior to gas entry into the unit.

The particulate matter captured by the ESP is a combination of lint, oil, and water which tends to form a viscous emulsion which coats the internal components of the ESP. This material is extremely difficult to remove and gradually builds up on the internal components of the precipitator.

4. Control Equipment and Design Evaluation

We were permitted to inspect two units which were giving the Company problems at the time. Not all the electrostatic precipitators are manufactured or purchased from the same vendor. However, discussions will generally apply to all units.

One unit was out of operation at the time of our visit due to necessary modifications to the ductwork. Both units inspected are of similar design (different

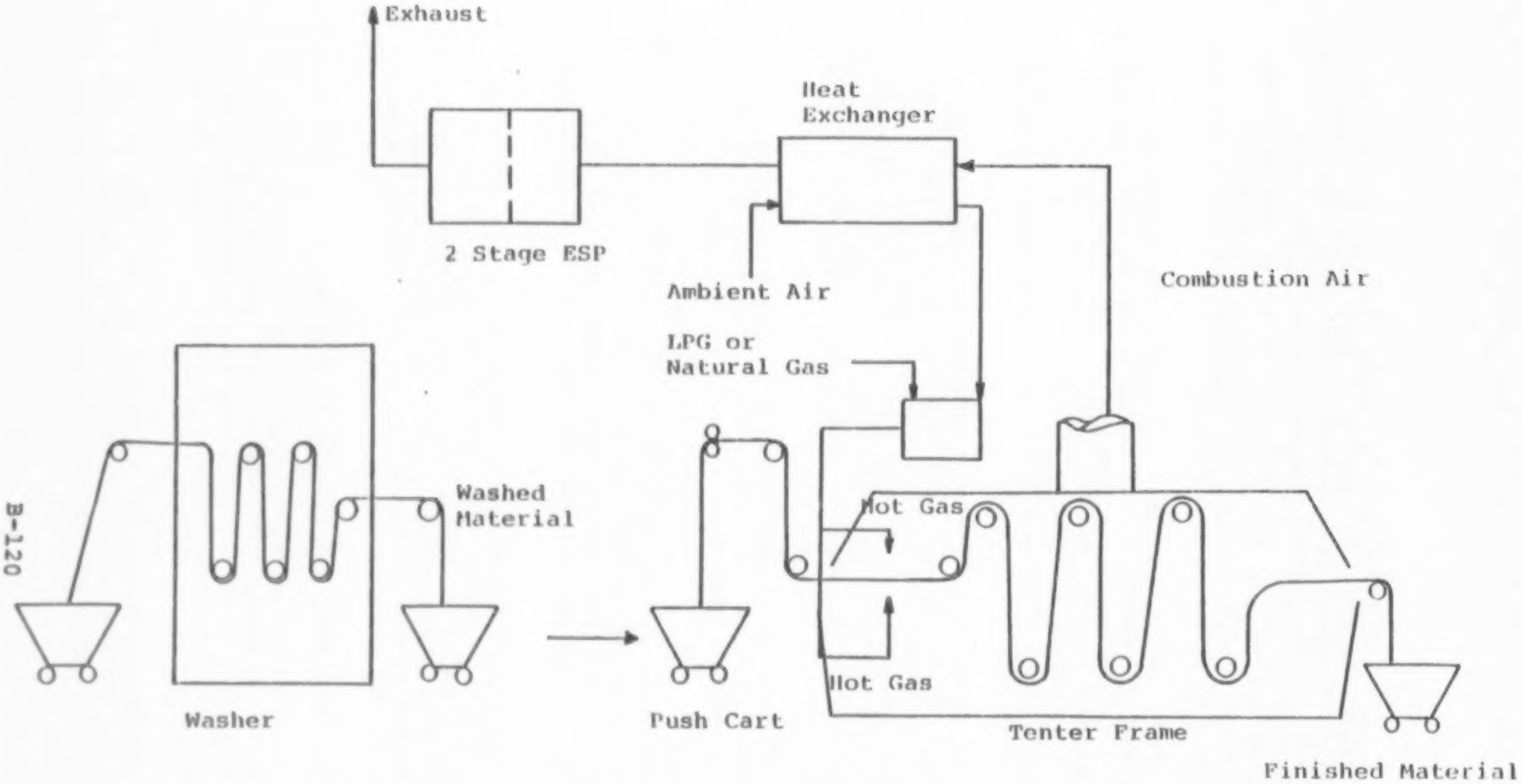

Exhaust
2 Stage ESP
Heat Exchanger
Ambient Air
Combustion Air
LPG or Natural Gas
Washed Material
Washer
Push Cart
Hot Gas
Hot Gas
Tenter Frame
Finished Material

Figure 1. Generalized Process Flow Sheet for Source 13.

vendors) with the major difference being the orientation of the ESP with respect to the ductwork. All ESPs are a two-stage positive corona design (two field). Each stage is separated into cells which may be individually pulled out of the rack mounting for inspection. The nominal volumetric flow rate through the units is 11,500 acfm @ 140°F. Volumetric flow rate through some other units may be somewhat less.

Instrumentation of the units is somewhat limited. There are two dial-type temperature indicators on the inlet and outlet of the heat exchanger. At the frame there are indicator lights for the operation of the fan, burner, provisions for ESPs status to be added in the future. Presently, operation status of each precipitator must be checked at the unit on the roof level. While the roof level units are very accessible, the indicators at the tenter frame control panel are highly desirable.

The ESP units were not designed to be operated above 175°F. Operating above this temperature results in the warpage of the plates. While it may be necessary to operate at the 140°F - 150°F range to condense and collect the oil mist efficiently, there is very little in the way of a designed safety margin when considering operating temperatures. A method of adding this extra margin of safety would be to use thicker gage plates since the thinner gage is susceptible to warpage. This would undoubtedly add to the cost of the unit and would likely add to the physical dimensions as well. However, higher operating temperatures can be foreseen during the summer months when ambient temperatures are high and only limited heat transfer can occur in the heat exchanger.

5. Control Equipment Performance Evaluation

When operating properly, the units have between 0% - 5% opacity at the outlet of the precipitator units. However, a number of problems have occurred and experience is still being gained in proper operation and maintenance of the units.

The major problem encountered has been wire breakage. This persistent problem has led to experimentation with different wire types. Most recently, gold wire has been used with a higher success rate than with previous vendor supplied tungsten wires. Though an expensive alternative, it may, in the long run, reduce costs when compared to current wire replacement costs. Another point of wire failure has been the wire support which is a spring loaded design to provide wire tension. The plant has switched to a slightly different design than was originally supplied by the vendor and has replaced most, if not all, of these mounting supports. The vendors have recently recommended that the Company should completely abandon this method of mounting in favor of direct mounting of the wires to the wire support frame. According to plant personnel and provide easier wire removal and replacement, however, the mounts now being used are quite satisfactory.

The task of finding and replacing a broken wire usually takes between 2 to 3 hours. When a field is tripped-out because of a short-circuit, there is no way of knowing whether it was caused by only one wire or by more. Each cell in the field must be pulled and examined to find and replace all broken wires.

There have also been problems with insulators and transformers at this plant. One unit has required extensive insulator replacement since its operation began in June 1975. The transformer problems have occurred in units manufactured by both vendors. Transformer replacement has required between 4 to 6 hours in the past.

The method of cleaning the wires and plates is not completely adequate or satisfactory. Cleaning of the ESP is accomplished by manually activating the cleaning device once a week. The automatic cleaning device consists of an array of spray nozzles which wash down the plates and ionizing wires with hot water. Because of the nature of the captured particulate it tends to coat both the wires and plates. This gradual build-up slowly deterioates the performance of the ESP over a period of months and finally the unit must be taken down and off-line for a soaking in an appropriate solvent solution. There was no solvent or detergent material made specifically for this emulsion and some experimentation was necessary to determine the most suitable solution. It was emphasized that this solvent may not be suitable for cleaning ESPs in other textile uses because the nature of the emissions is highly individualistic depending upon the plant function. Currently, this soaking of the ESP components occurs approximately every 6 months.

A special problem with corrosion has occurred in one of the ESPs. The arrangement of the control unit with respect to ductwork has allowed the unit to be shortcircuited when corrosion and scaling from the ductwork have fallen into the plate area. The corrective measures taken by the plant is to line the ductwork with a suitable material to prevent further scaling. The Agency regional office has allowed the tenter frame to operate without a control device until the modifications are completed.

5.1 Preventive Maintenance

The Company provided us with an estimate of 32 manhours per week devoted to inspection and maintenance for all seven ESP units at the plant. The units are inspected daily on the first shift at 7:00 a.m. (or daybreak in the winter). However, a specific routine used by maintenance personnel was not outlined for us. Some units have given more problems than others. For example, one unit may trip-out anywhere from 1 to 4 times a day, while another unit may trip-out only once a month. The behavior of each unit is highly individualistic.

5.2 Recordkeeping and Monitoring

Detailed records are maintained concerning replacement part costs and were provided by the Company. No operation and maintenance logs were indicated to be kept. No detailed records concerning malfunctions were provided; however, they are known to be quite numerous.

We would recommend to the Company the implementation of the maintenance of a bound log book to record all maintenance performed on the ESPs. Information should include which unit maintenance was performed on, type of malfunction encountered, when malfunction occurred, type of maintenance performed, designation of maintenance as corrective or preventive, when unit was restored to normal operation, and any comments on conditions noted by maintenance personnel. This may help plant personnel identify, more specifically, problem areas in the operation of the precipitators and to direct their attentions to correcting deficiencies and to optimize their preventive maintenance program.

5.3 Emissions

The emissions from these units have not been evaluated by a stack test. In general, some form of extension would be required to meet Method 1 criteria. Normal operation of the units allows opacity to be 5% or less. The units can operate under the 40% opacity limit with one field out (generally under 20% with one field out). This has been done on several occasions, particularly when the malfunctions occur at the end of the first shift. Since maintenance personnel are only on the first shift, the system may have one section out for approximately 16 to 20 hours before the situation is corrected the next day. When an ESP system is out of compliance with opacity regulations the frame is not operated. Figure 2 shows or estimates of the emissions profile for one of the ESP units at the plant. An estimation of potential errors is also shown in the figure. Figure 2 should not be construed as representative of the emission from the other ESP since this unit is the largest at the plant. Furthermore, the emissions profile does not represent emissions from any other textile mill. Each mill has emissions that are individual in character and require a case-by-case evaluation.

5.4 Spare Parts Inventory

The recommended spare parts inventory includes:

	Cost
1 high-voltage transformer	$275
1 500 ft. roll of ionizer wire	$150
Insulators	total cost unknown
Pins and hooks	total cost unknown

It is our estimation that the total dollar value of spare parts is between $800 and $1000 based upon a listing of previous parts costs incurred. All parts, with the exception of the transformer, are available on relatively short notice. Delivery time on the transformer is from 4 to 8 weeks.

The spare parts inventory seems adequate for this operation and what may normally be expected of the precipitator operation. However, there have been occurrences where a tenter frame has been operated uncontrolled because of necessary major modifications and lack of parts to complete modifications. The State agency has always been informed of these occurrences.

5.5 Other Comments

We learned from our discussions with both plant and State agency personnel that the source/agency working relationship is excellent. The plant management has made and is committed to a conscientious effort to maintain and properly operate the control equipment. The State agency is sensitive to the problems encountered by the

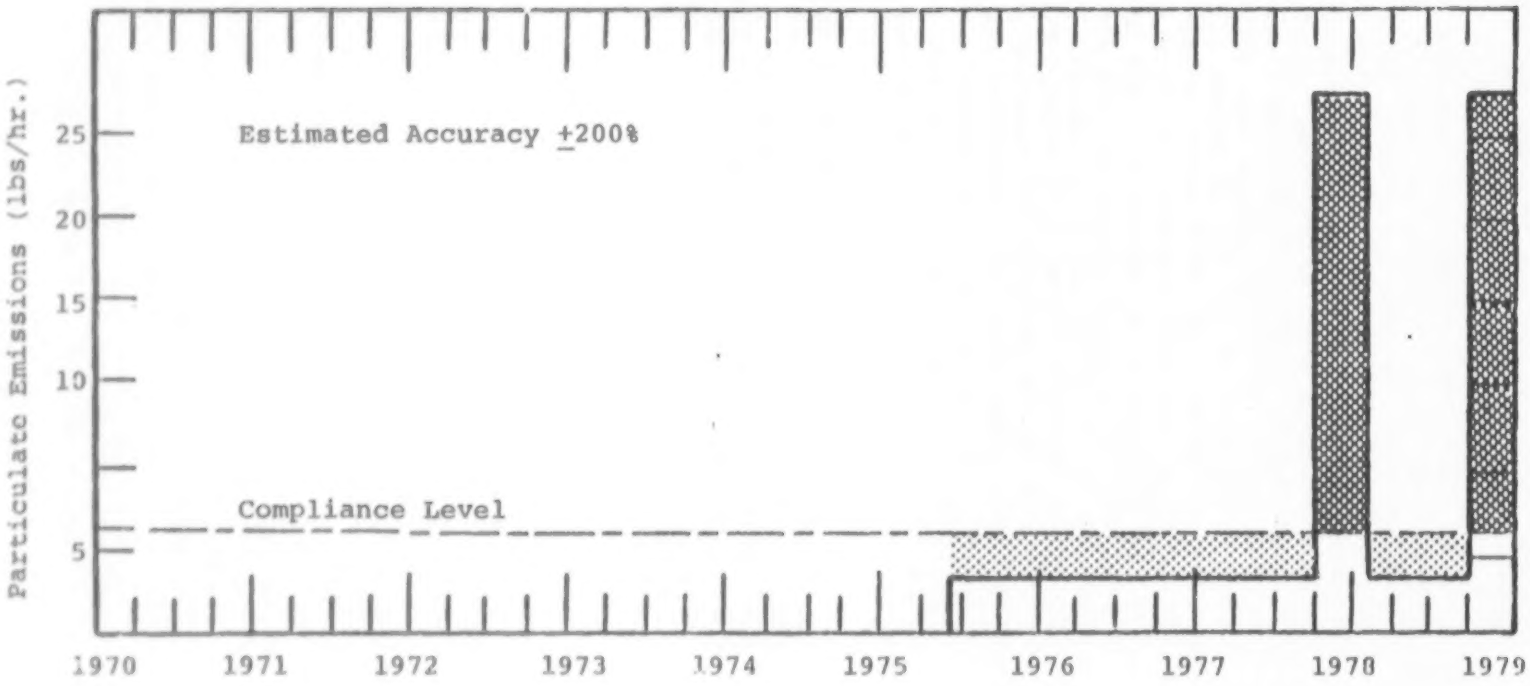


Figure 2. Estimated Emissions Rate for Source 13.

textile industry in its attempt to control emissions.

In this type of application where the particulate matter is a hydrocarbon that is primarily characteristic of being a sticky oil, there is no well-defined method of control. The use of a baghouse is out of the question because bags would be blinded in a very short time. The use of a scrubber would likely control emissions but would require waste water treatment and separation ponds. Separation of the organics from the water may be difficult, in this case, because of the tendency of the hydrocarbons to form an emulsion that is difficult to separate. The application of electrostatic precipitators is not without its problems as is noted in this report. This Company and other textile firms have experienced fires within ESP units controlling similar sources at other locations that have required complete replacement of the units. Furthermore, the individual nature of each textile mill and its emissions makes selection of a control technique more complex and requires a case-by-case review.

In this particular instance we feel that the selection of ESPs to control emissions at this plant was a proper choice. As plant personnel gain more experience in operaton of the precipitators, and design deficiencies are identified and corrected, we feel a more optimal use of maintenance manpower will be developed with an effective preventive maintenance program.

6. Costs

A detailed listing of parts costs was supplied for both the ESPs manufactured by both vendors. Most systems began operation in 1977 and 1978 though one unit began operation in 1975. Costs (parts) incurred on the units since 1975 until August 1978 totaled $4,300 over and above warranty work. Cost (parts) on the other 6 units have totaled $2,000 from 1977 until August 1978. An estimated $15,000 per year is spent on labor for all units. However, as mentioned previously, some units require more attention than others. A summary of parts cost by year is included. The system have not been operating long enough to establish a pattern with respect to costs. A majority of the costs are incurred due to replacement of transformers, insulators and wires in both type os systems. Each new system cost an estimated $90,000 with an estimated value of $7,000 - $8,000 for each cell in a field.

Summary of Parts

ESP Manufacturer

Year	Vendor 1 (1 unit)	Vendor 2 (6 units)
1975	$ 1450	-
1976	$ 240	-
1977	$ 2115	$ 315
1978 (thru 8/78)	$ 570	$ 1700

INSPECTION REPORT

Source 14

1. Summary of Visit

This source provides an example of a source which maintains no cost, operation, or maintenance records. Furthermore, the State agency has had to put substantial pressure on the source to maintain equipment, including the threat of non-renewal of the operating permit. There is little or no economic incentive for the source to maintain the control equipment which is 25 years in age and captures a particulate which has no economic value. There is minimal preventive maintenance.

2. Chronology of Source/Agency Contacts

1972 - November. Agency investigates reason(s) for delinquent registration forms. Source applies to regional office for operating permit. (Note: this regional office is no longer in existence. It is possible that not all of the correspondence and records were transferred to the appropriate files.)

1973 - July. Agency contacts source for the purpose of conducting a compliance evaluation; Source not operating.

- October. Agency inspects source while operating and finds heavy dusting problem (fugitive dust). Source must develop plan to control dusting problem.

- November. Agency notifies source that plans are past due for permit. Source notifies agency that plans are proceeding on placing water spray placement and hooding and ducting to existing baghouse.

- December. Source reapplies for temporary operaing permit to agency central office.

1974 - March. Temporary permit granted by the agency.

- May. Source applies for operating permit on sizing/screening tower to be controlled by fog sprays and baghouse to control fugitive dust.

- September. Routine inspection; wind affecting water spray effectiveness resulting in dusting from screening tower. Wind screens or enclosure of tower recommended to source.

- December. Routine inspection; source appears to be in compliance with opacity limitations.

1975 - March. Routine inspection; excessive dusting from screening tower. Water sprays not operating. Inspector recommends operation of water sprays at all times.

- May. Follow-up on complaint of dust. Screening tower dusting although water sprays in use. Unable to complete inspection due to sudden rainstorm.

- June. Routine inspection; baghouse in need of maintenance. Determination that there are inadequate number of water spray nozzles to prevent fugitive dust emissions from screening tower. Follow-up correspondence; Agency recommends internal inspection of baghouse, additional water sprays, and additional hooding to baghouse.

- August. Follow-up inspection; dust observed coming from baghouse exhaust. Another inspection reveals that the sprays have been modified and bags in baghouse will be changed.

- September. Follow-up inspection; screening tower and baghouse appear to be in compliance with opacity regulations.

- October. Follow-up inspection; some bags leaking in baghouse.

1976 - January. Routine inspection; slight dusting from screening-tower but appears to be in compliance with opacity regulations. Follow-up inspection reveals baghouse emitting dust although the bags were recently changed.

- April. Routine inspection; excessive emissions from screening tower and baghouse. Out of compliance with opacity limitations. Agency performs follow-up inspection to evaluate operation of source; internal inspection of baghouse reveals some bags fallen off their hangers and 6" to 12" of dust in bottom of baghouse compartment. No method exists to determine when hoppers need emptying.

- May. Meeting between source and agency to discuss continuing noncompliance of source and results of internal inspection.

- June. Follow-up inspection; baghouse in compliance with opacity limitations. Fugitive dust emissions from screening tower because water sprays turned off.

- July. Routine inspection; no inspection made because source was making repairs and not operating.

- August. Routine inspection; modifications and additional hooding being installed on screening tower. Follow-up inspection; slight dusting from screening tower requires more water sprays for dust suppression.

- October. Routine inspection; baghouse in compliance with opacity limitations although slight emissions observed from baghouse exhaust.

- November. Routine inspection; baghouse in compliance with opacity limitations. Screening tower in compliance with opacity regulations.

1977 - January. Routine inspection; screening tower dusting heavily due to freezing of water spray supply lines.

- February. Source contracted by letter from agency and notified that a number of problems have not been corrected. If not corrected, the agency will have to void the operating permit or refuse renewal when permit expires. Routine inspection; reveals heavy emissions from screening tower in excess of opacity limitations.

- March. Progress evaluation; screen tower toured during lunch. Baghouse in violation of opacity limitations.

- April. Progress evaluation; extra sprays may be necessary to reduce fugitive emissions. Some sprays not turned on. Routine inspection; baghouse in compliance with opacity limitations.

- June. Source applies for permit renewal.

- July. Routine inspection; baghouse found out of compliance with opacity regulations during two separate inspections.

- August. Agency grants operating permit renewal. Follow-up inspections; baghouse in compliance with opacity limitations after some bags were replaced.

- October. Routine inspection; baghouse emitting dust and probably needs maintenance. No compliance determination made.

- November. Routine inspection; source not operating.

1978 - February. Routine inspection; baghouse in violation with opacity limitations and water spray supply lines frozen. However, dust from screening tower not very severe. Follow-up inspection; baghouse remains in violation of opacity limitations.

- May. Routine inspection; baghouse repaired and in compliance with opacity limitations.

- July. Routine inspection; fog nozzles added and effective. Baghouse in compliance and source will keep between 100 - 300 bags in spare parts inventory.

- October. Routine inspection; all source in compliance with opacity limitations.

3. Plant Description

Blocks of granite are blasted out of the quarry where they are cut, crushed, and sized according to specified requirements. Of particular interests in this project was the baghouse controlling emission screening tower emissions.

As the granite is crushed and sized by screening, fugitive emissions from the screening tower are controlled by a combination of water sprays (fogging sprays) and fugitive dust ducting and hooding to the baghouse. The material captured by the baghouse was once an economically viable and commercially sold product. The gas off-takes are combined and fed to a baghouse (total gas value 24,100 scfm air) with 96, 6 ft. long, 10 oz. cotton sateen bags which provides 8,649 ft^2 of cloth area (air/cloth ratio: 2.79). The baghouse is a mechanically activated shaker design with hoppers that are emptied out on the ground once per day. Periodically, this material is loaded into a truck by a front loader and hauled off. This material was once marketed as "canary grit" and has a size equivalent of approximately 325 mesh (roughly the consistency of portland cement). The economic viability of this product has decreased substantially in recent years and the baghouse is now used for control of fugitive dust rather than to economically recover a marketable product. The other crushed stone products obtained from the screening tower operations are either bagged or sold in bulk quantities.

4. Control Equipment Design Evaluation

The baghouse used by this plant was designed and installed in 1953. Though the internals of the unit could not be inspected to compare with present day designs, certain external features could be noted.

The baghouse, itself, was in need of paint as there were several sections of the shell which showed severe rusting. The access ladder and catwalks had a pronounced twist from their supports, showing definite signs of stress. The overall impression was that a new baghouse will have to be purchased in several years.

Access to the bags is provided by 3 doors spaced so that approximately 1/3 of the bags are accessible through any door. The catwalk and access doors are about 20 ft. above ground level. There are no temperature or pressure drop sensors or indicators for the baghouse (the operating temperature of the baghouse is at or near ambient conditions). There is no insulation used.

The baghouse hoppers are not as steep in design angle as they are in current designs. There were parts of an old screw conveyor suspended near the hopper exits. However, the conveyor is no longer used and the hoppers are emptied periodically by manual methods.

The dumping of the captured particulate on the ground can create a fugitive dust problem. This merely allows some of the dust to be reentrained in the wind rather than controlling the problem (although the problem is not as severe as it would be without any type of control).

5. Performance Evaluation

5.1 Preventive Maintenance

A limited maintenance program exists at this Company. The bags are checked once every two weeks for apparent worn or dropped bags. The bearings on the fan motor are checked once every two months. The fan, even though located on the dirty-air side of the baghouse, has operated fairly well with few apparent problems.

5.2 Recordkeeping and Monitoring

No records on the operation or maintenance of the baghouse are kept. Repairs are made when required. No process monitoring is performed such as measuring baghouse pressure drop or fan current. We would recommend that, at a minimum, pressure drop be monitored.

5.3 Emissions Tests

No emission tests have been performed on this unit. Generally, it is the policy of the state agency not to stack test baghouses. Violations are noted strictly on the basis of opacity readings and these are performed by the State personnel during routine inspections. Because of the lack of data emissions profiles could not be prepared.

5.4 Spare Parts Inventory

The Company keeps a spare parts inventory worth approximately $750 which includes approximately 100 bags, 50 bag hangers, and spare parts for the shaker mechanism (if available). Delivery time is approximately two weeks for parts that are still supplied. For parts no longer manufactured, replacements have to be scavenged or adapted from a similar apparatus for the unit to become operational again.

5.5 Other Comments

The screening tower sprays and baghouse operation have been the subject of much scrutiny by the State agency regional office in recent years. Actions taken by the State include source inspections on very short time intervals (e.g., once every week) to the threat of permit revocation by nonrenewal. Problems noted by the State are 1) improper use of water sprays to suppress dust in the screening tower, and 2) improper or lack of maintenance of the baghouse (i.e., rehanging fallen bags and replacing worn bags).

Clearly, at some times of the winter dusting from the screening tower may occur because of frozen sprays. However, at other times water sprays are simply not turned on. The use of these water sprays is beneficial to reducing dusting problems in the screening tower but may contribute to the hopper bridging problems experienced at the baghouse. The moisture carryover, which may contribute to agglomeration, combined with the shallow angle of the hopper design often requires that the hopper be "dug out" to empty them.

The expected baglife may vary anywhere from 6 months to two years. No study has been made to correlate baglife with bag position, but the estimate is based upon the operator's perception of bag replacements. Because of the abrasive qualitites of the particulate matter, it is expected that the baglife may be from 6 months to 1 year.

Other occurrences of failures are 1) in any 6 month period, 8 to 10 bags may be expected to fall off their hooks. The lack of a bag in proper position obviously affects baghouse performance; 2) the shaker mechanism may be expected to fail about once a year. Since the shaker mechanism is old, parts are hard to find and adaptations sometimes have to be made.

It is doubtful that the agency could do much more to keep this source in compliance, short of accessing civil penalties or revoking the source's operating permit. It is also unlikely the source is performing the maximum efforts necessary to maintain compliance, although the control device is of considerable age. In the future the source will probably be required to replace the existing unit and this may prompt a more complete and effective preventive maintenance program.

6. Costs

No cost data for operation and maintenance of the unit was provided or kept. No record of the purchase cost of the baghouse was available. However, a replacement baghouse would cost many times more than the original unit due to inflation and other factors. It is suspected this unit will be operated as long as permitted by the State, before a replacement is sought. This unit has been run without all the necessary parts in place and it is likely this situation will continue before a new unit is purchased.

INSPECTION REPORT

Source 15

1. Summary of Visit

Despite good faith efforts to comply, the Source purchased equipment which was improperly designed to withstand the corrosive and abrasive qualities of the gas. A vendor provided the new equipment but modifications were incorporated by the Source at additional cost. These modifications provided more reliable operation and easier access for necessary maintenance. Operation of the re-engineered control equipment has been very successful and relatively trouble free.

2. Chronology of Source/Agency Interaction

1971 - December. Source applies for temporary operating permit. Source originally selected baghouse for control and subsequently modified permit application to specify a scrubber system.

1972 - February. Permit granted by the State.

- October. Scrubber construction began.

- December. Temporary permit expires.

1973 - January. Source applies for operating and construction permit for control device.

- April. Permit granted by the State, unit to be in operation by August 1973.

- May. Adverse weather and delivery problem force amendment of permit; unit to begin operation October 1973.

- October. Scrubber tested for acceptance by vendor; meets specifications. Apparent initial compliance with regulations.

- December. Scrubber fails due to inadequate protective lining and subsequent corrosion. Requires redesign and installation of new unit. Replacement provided under warranty, modifications and costs of new linings paid by Source.

1974 - September. Routine inspection; construction progressing on schedule.

- November. Routine inspection; installation continuing on schedule.

- December. Routine inspection; installation continuing on schedule.

1975 - February. Routine inspection; installation continuing on schedule.

- May. Routine inspection; installation continuing on schedule.

- September. Unit is completed and determined to be operating in compliance with visible emission limitations during a routine quarterly inspection.

- October. Stack test performed and unit found to be in compliance with mass emissions limitations.

1976 - January. Scrubber operating in compliance with visible emission regulations (routine inspection). Unit was down for six days to repair refractory lining in impinger.

- April. Routine inspection; Source found to be in compliance with visible emission regulations.

- December. Routine inspection; scrubber down for relining of internal components (outage of 5 days).

1977 - January. Source applies for permit renewal. Scrubber in operation and found to be in compliance with visible emission regulations.

- February. Permit renewed by State.

- May. Routine inspection; Source in compliance with visible emission regulations.

- September. Routine scheduled inspection. Source in compliance with visible emission regulations.

- November. Routine inspection; Source in compliance with visible emission regulations.

1978 - May. Routine inspection; Source in compliance with visible emission regulations.

3. Plant Description

Three coal-fired industrial boilers are utilized to generate steam and to provide space heating. The subject of this inspection report is one pulverized coal-fired boiler of 60,000 lbs of steam/hr rated capacity controlled by an unusual wet impingement scrubber. The sulfur content of the coal is typically around 1% with approximately 5% ash content. The coal data estimates provided by the Source appears unusual because of the 5% ash content which we feel is low.

4. Control Equipment Design Evaluation

The wet-impingement scrubber system can be divided into 3 separate sections: 1) the primary collector/saturation chamber, 2) the impingement cone, and 3) the impingement plate/separator chamber. The gas entering the primary collector has a temperature of approximately 350°F and a volumetric flow rate of 25,000 acfm prior to cooling. Spin is imparted to the gas flow as it enters the top of the collection/saturation chamber and the gas is subject to water spray of 10 gpm which cools the gas to approximately 150°F.

The gas leaves the primary collector/saturation chamber and enters the cone area where the particulate matter impinges upon the water droplets introduced at the cone entrance. The unit mechanisms (theoretical particle collection mechanisms) employed by the system are reportedly quite similar to that employed by a venturi scrubber. The highest collection efficiency occurs in the region of greatest droplet acceleration. However, unlike a venturi where the combination of gas velocity and scrubbing liquor addition in the throat forms droplets, the water in this scrubber must be introduced as droplets. A spray ring with 6 spray nozzles generates the water droplets at a rate of 25 gpm. These nozzles were placed on the outside of the unit for easy repair or replacement during the operation of the unit. Each nozzle is equipped with a flow control valve so that other nozzles can continue operating while a nozzle is replaced. The nozzles are 1/8" orifice fan spray types and produce a very fog-like spray. Plastic lines, used to supply water to the nozzles, are subject to deterioation; however, this has not developed to date.

After passing through the cone, the gas enters the separation chamber where the water droplets/particulate matter impinge upon a plate which is washed down with water. The gas is then forced down and through the water held in the tank (self-induced impingement) to further remove particulate matter. Finally, the gas passes through a chevron type mist eliminator, through the ID fan and out the stack. Sampling parts are located approximately 75 ft. up the stack.

The control equipment is located on the roof of the powerhouse. All necessary equipment is accessible by ladders, catwalks, and access doors. The design has been refined to the extent that the parts most subject to failure allow reasonable access for repair.

The scrubber unit operated by the Source is essentially a second generation custom design. The first unit installed by the vendor failed to withstand the corrosive and abrasive materials released by the boiler. Failure occurred in a relatively short period of time. The unit, being lined with fiberglaze (a fiberglass lining), failed to withstand the gas conditions. The unit was under a vendor warranty and was replaced with a similar unit.

It is conceivable that a more effective permit review program would have identified the serious corrosion potential of SO_2 contaminant effluent. There are a number of reported corrosion failures due specifically to inadequate pH control in coal-fired boiler scrubber systems. Failure of the first scrubber at the plant should have been predictable. The oversight on the part of the Company and the Agency resulted in 2 years of uncontrolled emissions (repair of system) and a substantial financial penalty for the Source.

The replacement unit was lined with refractory and butyl rubber. A more resilient refractory lining was placed in the saturation chamber and butyl rubber was used in the cone. Refractory material replacement is relatively quick and simple.

Though the unit is not insulated, no major problem with freezing has been experienced in winter except, perhaps, with the cone spray nozzles. Corrosion does not appear to be a major problem and the lining seems to be protecting the unit well.

The fan impeller is coated to protect it from corrosion. Plant personnel indicated that though stainless steel may have given better service, this fan has been acceptable.

Water is used in a "once-through" mode. The water is sent to a settling pond before waste water treatment. The pH of the waste water is approximately 2.1 to 2.5 depending upon the specific origin of the water. The low pH is due to the absorption of SO_2. The absorption of SO2 is accomplished primarily in the saturation chamber according to water analysis of the effluent liquid stream. The Source has not been tested nor is required to test for SO_2 output due to the use of low sulfur coal.

Instrumentation consists primarily of a temperature indicator in the saturation chamber and a fan amperage meter. A safety interlock is built into the system to keep the temperature below 175°F. In the event the temperature does climb above that point an alarm is sounded and an auxillary water spray is activated in the saturation chamber to bring the temperature back down to the desired level. Pressure drop across the scrubber system is approximately 4 in. H_2O.

Data presented later in this inspection report clearly indicates that the unit has been operated in compliance for an extended time period. Obviously the design is adequate. Nevertheless, theoretical models would probably indicate a very low probability of compliance. This probability illustrates a case where strict application of such models in permit review could erroneously predict failure of a system and force selection of unnecessarily expensive control systems.

5. Control Device Performance Evaluation

The performance of the modified scrubber unit has been satisfactory. The modifications made by the Company has prevented the problems encountered with the original unit. The spray nozzles have worked effectively since inline filters have been used to prevent nozzle pluggage. Testing of this unit has demonstrated a 98.7% control efficiency.

The major problem areas have been the fan and the mist eliminator. Plugging has been encountered with the mist eliminator, while the problem with the fan has been the flaking off of the impeller lining causing the fan to run out of balance. Thus, the fan has to be repaired. No major corrosion problems have been noted. Total downtime since operation began in early 1974 has been only 12 days. This is a very high availability compared with scrubbers on power plants and similar applications. A stand-by system consisting of some old Buell mechanical collectors is still in place for use if the scrubber unit is down for repairs but the steam production is needed. These collectors are not very efficient.

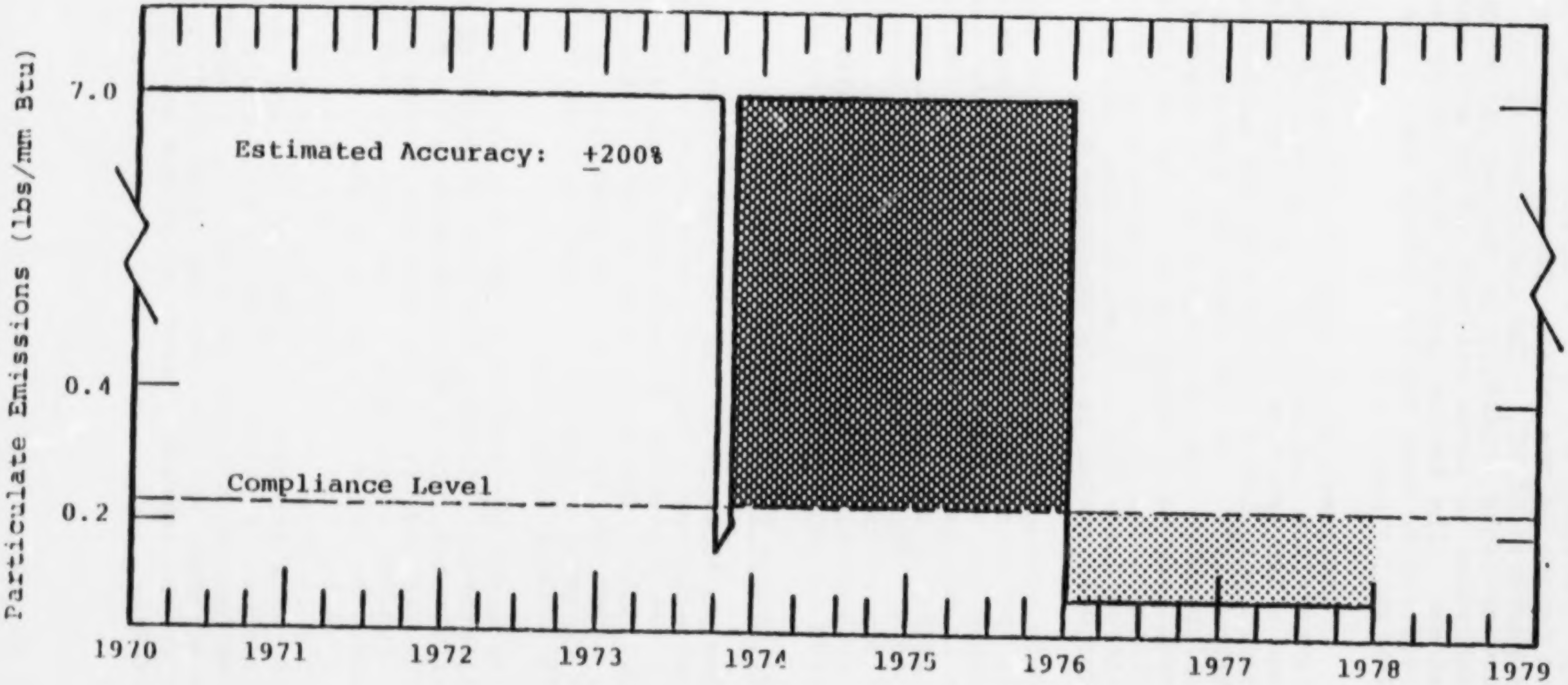


Figure 1. Estimated Particulate Emissions Rate for Source 15.

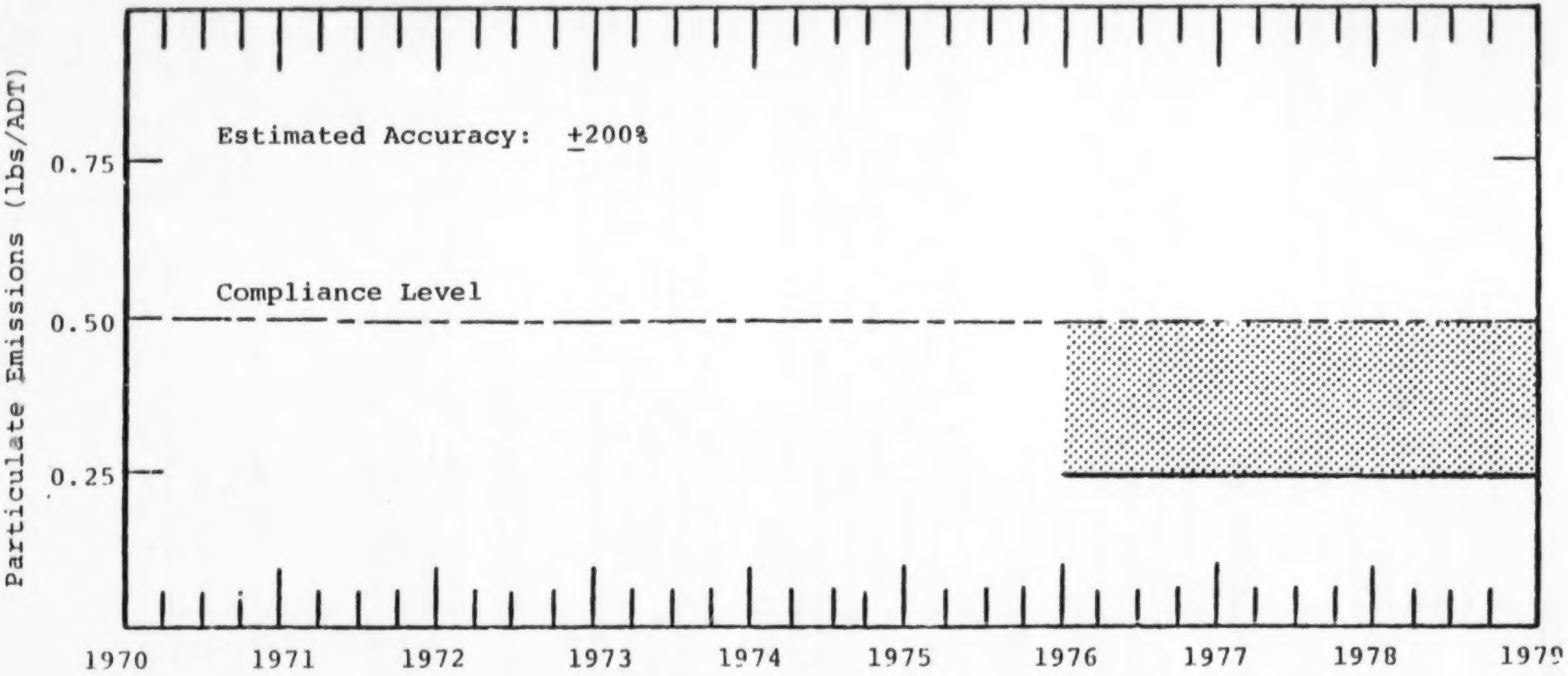


Figure 1. Estimated Particulate Emissions for Source 16.

5.1 Preventive Maintenance

Other than the daily checks to confirm the equipment is operating properly, all other preventive maintenance is performed weekly. This consists mainly of checking nozzles for proper operation and hosedown of the mist eliminator to prevent plugging. Other maintenance, such as replacing linings on the fan or scrubber system, is performed as needed.

5.2 Recordkeeping

No records are maintained. Old work orders are kept on file but these are not differentiated from other systems in the plant. No explicit records are kept on the day-to-day operation of the unit.

5.3 Emissions

An emissions test has been performed and the unit passed with an emission level of 0.07 lb/10^6 Btu. Allowable emissions for this unit are 0.24 lb/10^6 Btu. There is no evidence available to suggest the unit has ever been operated out of compliance with either opacity or mass emission limitations. When repairs are needed, the boiler is shut down.

Based on the one stack test and quarterly opacity checks, the annual emissions profile of Figure 1 was prepared. The estimated accuracy of this profile is ±200%. Boiler load is relatively constant, therefore, diurnal cycles are not expected.

5.4 Spare Parts Inventory

Spare parts kept on hand consist primarily of spray nozzles and nozzle filters. An estimated value of the total inventory is $400, which has proven sufficient for this particular system.

6. Costs

The total capital costs of the system were approximately $70,000. Included in this figure is the first unit which failed and $30,000 - $40,000 of modifications made to the present system. Annual operating and maintenance cost are estimated at $12,000 per year.

INSPECTION REPORT

Source 16

1. Summary of Inspection

A venturi scrubber controlling emissions from a kraft pulp mill rotary lime kiln was inspected. This scrubber is located at the same plant as Source Number 6. Many of the general comments made concerning the agency and source are applicable here.

There are four lime kilns located at this plant. Of concern in this study was the new lime kiln constructed in 1975 to accomodate additional capacity of the pulp mill. The lime kiln has operated relatively trouble-free since its startup in 1976. Relatively little data was available from the state or the source concerning the nature of the emissions profiles for the units.

2. Chronology of Source/Agency Interaction

The Company has numerous sources located at the plant, many of which are covered by separate operating permits. To simplify matters, only the major areas of concern will be presented in the chronology.

1970 - November. Source applies for temporary permit to operate air pollutant sources.

1971 - February. Agency grants temporary permit to Source.

1972 - December. Source applies for new temporary permit to operate air pollutant sources. Previous permit expired.

1973 - February. Source applies for construction of new low-odor recovery boiler and ESP to control particulate emissions. Agency grants permit.

- March. Agency grants temporary permit to Source. Source must develop plan of action to bring plant into compliance with state regulations.

1974 - March. Source applies for permit to construct and operate venturi scrubber on lime kiln. Two other kilns already controlled by scrubber.

- *April*. Agency grants permit for scrubber.

1975 - *July*. Source applies for permit for modification of one existing recovery boiler, addition of new ESP's for existing recovery boiler, construction and operating of new lime kiln controlled with a venturi scrubber; other miscellaneous equipment included.

- *August*. Routine inspection; existing lime kiln with new scrubber operating and in compliance with opacity limitations.

- *September*. Compliance evaluation; existing boilers out of compliance with odor and opacity regulations.

- *October*. Agency grants permit for recovery boiler modification and new lime kiln. Apparent initial compliance with emissions regulations.

1976 - *December*. Source applies for permit renewal for new recovery boiler.

1977 - *February*. Compliance evaluation; new lime kiln controlled and appears in compliance with opacity limitations. All other sources appear in compliance.

- *April*. Agency grants permit renewal for new recovery boiler.

- *May*. Routine inspection; modified recovery boiler modifications completed and in compliance with opacity limitations.

- *August*. Routine inspection; modified recovery boiler experiencing problems with odor control system. All other sources in compliance with opacity limitations.

1978 - *February*. Routine inspection; all sources appear in compliance with opacity limitations.

- *June*. Routine inspection; all sources appear in compliance with opacity limitations.

3. Plant Description

The rotary lime kilns convert $CaCO_3$ obtained from the kraft pulping process to CaO to be recycled into the process. Lime kilns are typically several hundred feet long and heated counter-currently. The four kilns at this plant are all of similar design.

4. Control Equipment Design Evaluation

The venturi-scrubber controlling particulate emissions from the lime kiln is a variable-throat design. The throat diameter is changed by changing an orifice plate in the nozzle of the venturi. Thus, the throat is not continuously variable but remains fixed until a change in throat diameter is necessary.

This venturi may be classified as a medium-energy venturi. Typical pressure drop across the venturi is approximately 16 inches water column. The gas flow is typically 33,000 acfm @ stack conditions (150^{o} - 180^{o}F). An ID fan is located on the inlet side of the venturi. Conditions of the gas stream are severe when considering particulate loading and the gas temperature of 400^{o}F and can lead to fan wear problems. Stainless steel is used throughout the system.

Water is introduced by 3 nozzles located at the tangential inlet of the venturi scrubber. These nozzles are aligned in the direction of flow to wet the walls of the venturi inlet. The water is atomized and vaporized as it passes through the throat which allows collection of particulate matter and cooling of the gas stream. The gas stream is then passed through a flooded elbow and into a cyclonic separator. Most of the collected scrubber water is recirculated and the remainder either goes up the stack or to a settling pond before discharge. Pump operation is interlocked to the kiln burner.

The design of this venturi scrubber is similar to the designs of the existing kilns. There is no reason to believe service should not be satisfactory. We questioned the use of the fan on the inlet of the scrubber. However, the plant personnel indicated it was a matter of choice between a hot, abrasive atmosphere or a moist, corrosive one.

5. Control Equipment Performance Evaluation

The operation of the control equipment has been relatively trouble-free. The two major trouble areas have been the fan and the main recirculation pump. The fan has presented some wear problems and one fan wheel has had to be replaced. The number of pump failures is not known by the source. However, only "several" have occurred which apparently have not required much time to correct.

There has not been any problems with freezing or abrasion within the structure of the venturi scrubber. There is a gradual buildup of material in the flooded elbow that requires periodic cleaning.

5.1 Preventive Maintenance

Relatively little preventive maintenance is necessary on this scrubber. The pumps and fans are checked for proper operation during each shift. The lime kiln/venturi are taken off-line for annual maintenance and clean-out. The nozzles are checked at this time for material buildup and replaced as necessary. Typically, maintenance requires less than 20 hours/month on all four venturis at this plant.

5.2 Recordkeeping

No long term data is kept on the operation of the venturi scrubbers. Once per shift the pressure drop, water recirculation rate, and water make-up rate are recorded. These records are kept for approximately three months and discarded. No maintenance records were kept by the source. In the case of venturi scrubbers, operation records such as pressure data are not very indicative of actual performance. However, we believe that at a minimum, the maintenance performed should be recorded in a bound log book. Though the corrective maintenance requirements are relatively low, a log book may help indicate recurring problems and suggest changes in preventive maintenance procedures.

5.3 Emissions

No formal stack test were available to us in either the state files or the records presented to us by the Source. The Source indicated that inlet load conditions were approximately one-half of the design, or 6,700 lb/hr, and outlet conditions were approximately 15 lb/hr. Tests on a similar unit reveal emission of one-half the standard. There has been no known violation of the emission or opacity standards.

5.4 Spare Parts Inventory

The source maintains a spare parts inventory for the venturis which consists of pumps, fan bearings, nozzles, and water flow controllers and instrumentation. Most parts are available locally and there are no occasions that we know of where excess emission were caused because of the lack of spare parts.

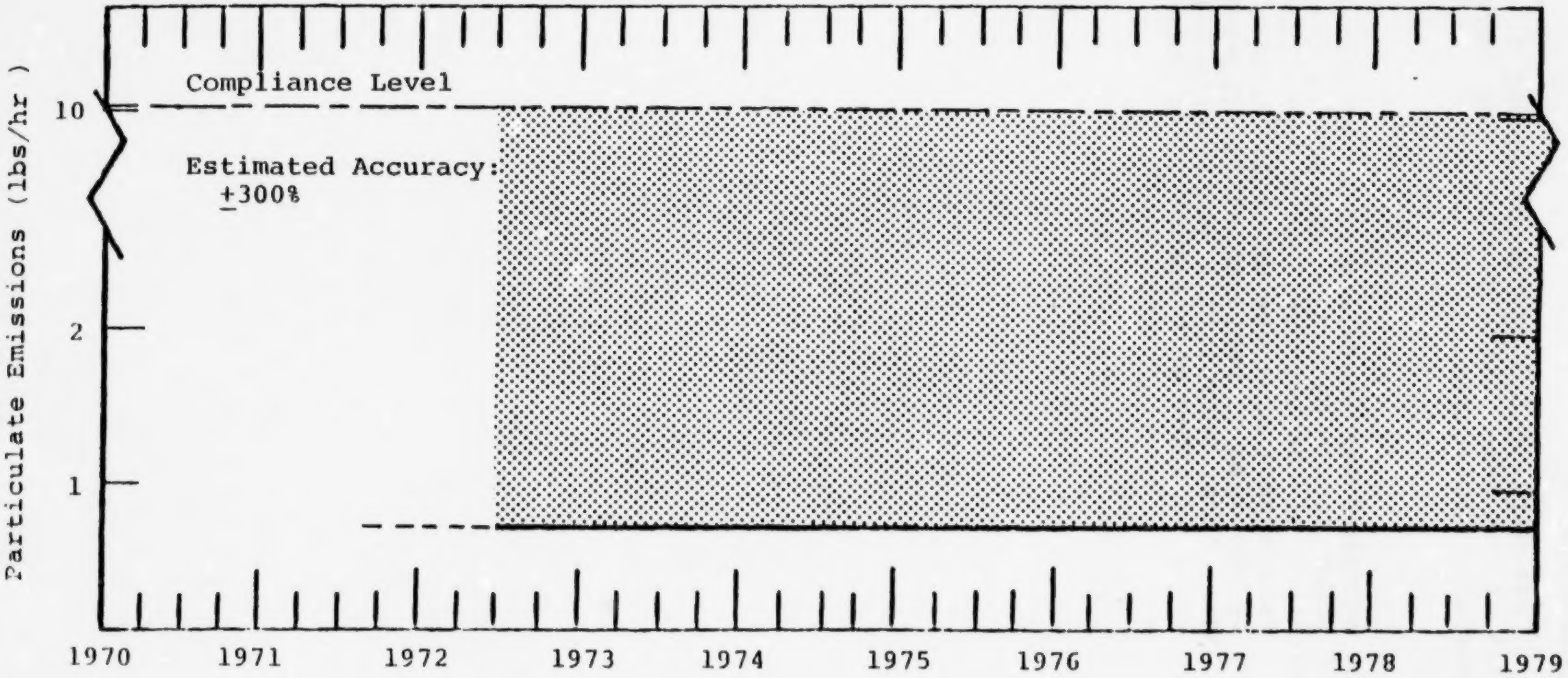


Figure 1. Estimated Particulate Emissions for Source 18.

5.5 Other Comments

See Section 5.5 of report number 6. Because this is the same plant location, the comments are generally applicable.

6. Costs

The scrubber was installed at an estimated cost of $500,000 (from Source permit). The Source estimated that operation of the scrubber costs approximately $15/hr. Maintenance of these units is further influenced by the cost of replacement CaO (present cost of $60/ton). Thus, very little downtime is expected. No labor costs or other maintenance costs were provided.

INSPECTION REPORT

Source 17

1. Summary of Inspection

The Company operates six afterburners to reduce visible emissions of organic particulates. In a strictly legal sense, the source is in compliance in that visible emissions are in fact consistently below 20% opacity. Contrary to the opinions of the plant engineer and Agency personnel, however, the compliance is probably not due to incineration of the contaminants. In our judgement, the operating temperatures of 400 to 600°F are too low to expect even minimal hydrocarbon incineration. The afterburners appear to function simply as stack heaters which prevent condensation of the hydrocarbon vapors until the effluent disperses beyond plant boundaries.

2. Chronology of Source/Agency Interaction

1970 - June. Agency requests information from the Source for a State Emissions Survey.

- September. Source delivers Emissions Survey data to Agency.

1972 - January. Agency delivers a temporary permit application to Source.

- August. Source delivers completed temporary permit application to Agency.

- December. Agency issues a temporary permit for continued emission of particulates, hydrocarbons, and visible emissions.

1973 - February. Source receives proposal from an ESP vendor.

- June. Source applies for a permit to construct and operate ESP control system.

- July. Source purchasess an ESP pilot unit.

- November. Pilot ESP operational. State agency inspector observers its operation and sees no major problems.

- December. Temporary permit expires.

1974 - March. Permit issued for operaton of seven ESPs for removal of visible emissions.

- June. Source receives proposal from vendor to construct the six additional ESPs.

- August. State revises permit to specify that all seven ESPs must be in operation by December 1974.

- November. Source receives a revised proposal from vendor for additional ESPs.

1975 - May. Agency requests a chronology of attempts by source to secure a workable control system.

1976 - February. Permit revised again to allow more time for construction. Permit specifies that facilities must be in operation by July 1976.

- April. Special Order of Consent agreed to by Source. Order specifies a schedule for achieving certain milestones in the construction of the control equipment.

- July. ESPs in operation. Agency inspection reveals that they are out of compliance with opacity regulations.

- August. Fire destroys one precipitator. Inspection reveals that some of the undamaged precipitators are still out of compliance.

- September. Source in compliance with opacity regulations.

1977 - Source replaces the ESPs with gas-fired incinerators.

- July. Source in compliance with opacity regulations.

1978 - April. Permit revised to allow source to operate incinerators for control of plume opacity.

3. Plant Description

The Company operates 3 vinyl coaters, 1 tenter frame and 2 curing ovens for the application of coatings to textiles. The emissions from these operations consist of the solvent vapors and impurities picked up during the process. The approximate composition of the uncontrolled emissions is reported by the source to be 93% straight chain alcohols, 3% low molecular weight esthers, 3% thallic anhydride, plus traces of oils, lints, and vinyls.

Emissions from the process sources are vented to a set of 6 natural gas afterburners mounted on the roof of the plant. The afterburners have capacities of 5,000 to 8,000 acfm @ 800°F and use up to 2,000 to 3,000 cubic feet of natural gas per hour. Effluent is released from the stacks at an elevation of approximately 30 feet above ground level. There are more than 30 houses within 1,000 feet of the plant.

4. Control Equipment Design Evaluation

The emissions sources were originally controlled by means of seven positive corona electrostatic precipitators. These units exhibited a rapid decline in efficiency resulting from an unexpected build-up of vinyl on the collection plates. Although vinyl concentrations in the fumes are quite low, they were sufficient to foul the plates. The coating resisted all conveniently employed cleaning methods. There were also fire problems with the fouled ESPs.

Thirteen gas fired afterburners were installed as replacements for the electrostatic precipitators. Six of these burners vent to the atmosphere and exhausts from the others are recycled for heat recovery. The burners which vent to the atmosphere utilize a proprietary combustion chamber design which supposedly enables the incinerators to efficiently oxidize the vapors at 400 to 800°F. Because of the proprietary design we were not able to review any drawings. We seriously question the vendor claims with respect to the efficiency of this unit. Even with catalytic systems, the minimum gas temperature requirements are normally in the range of 800 to 1000°F. Direct fired incinerators, such as those at the plant, normally require 1200 to 1800°F in order to operate efficiently.

We believe that these incinerators are similar to those used in the insulation fiberglass industy for the purpose of reheating the hydrocarbon vapors to prevent aerosol formation prior to release from the stack. The use of these devices appears to be consistent with most opacity regulations, since the pollutants are still in a vapor state at the point where opacity is measured according to Method 9. However, stack heaters do not appear consistent with the intent of the law since in some instances aerosols may form as the effluent drifts across plant boundaries. The unit postpones the appearance of the particulate but does not reduce the impact on the community.

5. Control Equipment Performance Evaluation

The incinerators have operated in continuous compliance (as defined by plume opacity regulations) since installaton. There have been no malfunctions or operating problems reported. During our inspection of 2 of the units, the gas temperature was 400 to 500°F. The plant engineer advised us that the temperature is kept at the minimum possible setting that prevents visible emissions. This is done to reduce natural gas costs.

5.1 Preventive Maintenance

The incinerators require very little maintenance. The plant engineer indicated that the units are checked once daily and that burner adjustments are made weekly. In addition, a gas burner technician performs a thorough annual safety check on each incinerator for insurance purposes.

5.2 Recordkeeping

The Company does not maintain any records on the incinerators. Considering the manner in which the units are operated, we do not believe anything would be served by maintaining records. If the units were being used as true incinerators, we would recommend that temperature be recorded once per day to demonstrate that combustion efficiency is adequate.

5.3 Emissions

The source did not disclose the quantity of solvent which passes through the afterburners nor was there information about these emissions in the State agency files. For this reason, it is not possible to construct emissions profiles for this source. The lack of information about emissions is due to the belief on the part of the source and the Agency that plume opacity is the only pollution parameter of concern at the plant.

Both the source and the Agency assumed that less than 5% of the solvent emissions are photochemically reactive hydrocarbons. According to State regulations any source which discharges more than 40 lbs. per day of organic materials containing more than 5% of specified photoreactive hydrocarbons must reduce those discharges by 85%. Unsaturated esters and alcohols are among the hydrocarbons considered photoreactive. There is no evidence that the State has analyzed a sample of the solvent mixture to see that the concentration of these photoreactive compounds is less than 5% of the total.

The compliance of this source with plume opacity regulations and the assumption of compliance with hydrocarbon emissions regulations raise interesting questions about the regulations' stipulations versus their intent. The opacity regulation permits the source to use a control device to improve the appearance of emissions without necessarily reducing the amount of the emissions. At the same time, the hydrocarbon emission regulation is concerned with the state of solvent vapors before they pass through the control device rather than the state of the vapors as they are emitted into the atmosphere. The regulation overlooks the possibility that exempt hydrocarbons could be transformed into photoreactive hydrocarbons by the control device.

5.4 Spare Parts Inventory

The source has not found it necessary to maintain a large reserve of spare parts for the afterburners. Thus far, they have required cleaning and adjustment only and have not required any significant replacement parts.

6. .Costs

The total installation costs of the seven electrostatic precipitators was approximately $250,000 (1974 dollars). An additional $4,000 was required to dismantle the precipitators after the decision was made to scrap them. The total installation costs of the six incinerators was not disclosed during the visit to the plant. Records of annual operating costs attributable solely to the control system are not maintained. Operating costs for the presently used incinerators include the costs of natural gas use and annual insurance certification inspection, plus less than 10 man-hours per month for routine inspection, cleaning, and adjustment of the incinerators.

INSPECTION REPORT

SOURCE 18

1. Summary of Visit

This source was visited in September 1978. During the visit, it appeared that the plant's two rotary dryers were in compliance with State regulations. Plant personnel seemed genuinely concerned about pollution, and the plant air pollution systems seem to be carefully managed. Based on information gathered during the visit and from State agency files, it can be assumed that the two dryers rarely, if ever, exceed the maximum allowable particulate emissions. Opacity violations are infrequent and of short duration. The good performance of the control equipment is maintained despite an unorthodox design and a lack of instrumentation and recordkeeping. The success of the equipment is due to a large safety margin in its initial design, and to the frequent attention given it by plant personnel.

2. Chronology of Source/Agency Interaction

1972 - August. Source visited for the first time. Equipment has been in service for several years. Based on opacity, the State recommends a stack test. Subsequent stack test reveals particulate emissions to be much lower than plumes would suggest. Source is in compliance.

- September. State requests Air Pollution Episode Plan (APEP) from the source.

- October. Permit issued. APEP also approved.

1973 - March. Complaint received. Complaintant contacted by the State on sixth attempt, after being unable to contact on five earlier attempts. Complaint concerned fugitive dust from vehicular traffic.

- April. Source inspected, and found to be in compliance.

- September. Second complaint received. Source agrees to reroute truck traffic.

1975 - December. Third complaint received; State promises to investigate.

1978 - March. Permit renewed.

- April. Stack test conducted; source found to be in compliance.

3. Plant Description

This plant produces ground mineral products and quartz sand from ores mined at a nearby mountain. The plant produces more than 100,000 tons/year of products.

Ores are first wet rod milled, then separated by froth floatation, and then drained. Separated materials (20 - 30 mesh) are transferred into rotary dryers that are fired with No. 2 oil. Materials are introduced into the dryers counter-current to the burner exhaust. Exhausts from each dryer pass through packed-bed, wet scrubbers prior to exhausting to the atmosphere (see Figure 1).

Each of the scrubbers, which were designed and fabricated by the source, contains three 4-inch thick layers of coke packing. Each coke layer is sprayed from below by an array of low pressure nozzles. Dryer exhausts enter each scrubber vessel at the bottom. Draft is induced in each scrubber by a fan located near the vessel outlet at the top.

The larger scrubber is designed to handle more than 20,000 acfm gas flow at up to 175°C, with an extremely high particulate loading. The unit is rectangular in construction with plywood side walls. Predicted maximum pressure drop across the unit is about 4 to 5 inches of water. The scrubber generally uses about 15 - 25 gal/min. There are about 50 type 304 stainless steel nozzles in the scrubber. The predicted efficiency of the scrubber is 99.5%.

The smaller scrubber is designed to handle about 15,000 acfm gas flow at up to 140°F, with a particulate loading of more than 300 lbs/hr. The unit is also rectangular in construction with wood side walls. Designed pressure drop across the unit is about 3 to 4 inches of water. The scrubber generally uses 10 - 15 gal/min. The predicted efficiency of the scrubber is 98.9%.

Effluent water from the scrubbers is transported to the plant water treatment facilities where the collected particulates are settled into a sludge and dewatered. Clarified water is recycled and pH controlled.

4. Process and Control Equipment Design Evaluation

The scrubbers at the plant have presented no significant operational problems since their installation. A State conducted stack test showed that particulate emissions from the smaller of the two scrubbers were less than 8% of the maximum allowed by State regulations. State inspectors also report that both scrubbers consistently meet opacity standards. The design of the scrubbers seems to be more than adequate to meet State regulations.

One important feature in the design of the scrubbers is their wood construction. The use of wood is most appropriate in view of the corrosive environment generated by the drying of flouride bearing ores with sulfur bearing No. 2 fuel oil. The scrubbing process generates sulfuric acid and hydrogen flouride, which are corrosive to both mild steel and stainless steel. Recirculation of the scrubbing water would tend to increase the concentrations of these acids.

One feature that is lacking in the plant is a lack of demisters just before the scrubber exhaust. During PEDCo's visit, liquid carryover was noted at one of the fans. This condition undoubtedly has a detrimental effect on fan life. The control equipment engineer did not view this as a major problem, indicating that the fan is replaced when needed. We believe this to be more costly in the long run than the addition of demisters. In addition, fan outages might someday cause a lengthy interruption in equipment operation, unless a spare fan is kept in stock.

The choice of a packed coke bed scrubber for this application cannot be evaluated because of a lack of particle size data. While it is clear that the units are quite efficient for the particulates at the plant, it is possible that other types of devices would have performed equally well. For packed bed scrubbers specifically, the use of a packing material other than coke would probably have been just as effective. Use of a ceramic or glass packing medium would have eliminated the need to change the packing material because of disintegration, as is the case with coke. The control equipment engineer, who joined the plant staff several years after installation of the scrubbers, did not know the specific reasons that packed coke bed devices were chosen over other types.

5. Performance Evaluation

5.1 Preventive Maintenance Program

There is no formal preventive maintenance program performed for the two coke bed scrubbers. However, the plant control equipment engineer, whose sole responsibility is managing air and water quality and the work environment, devotes a substantial portion of his time to the scrubbers. Several times daily he observes the plumes emitted from the scrubbers and visits the scrubbers to check for water leaks and to check fan operation. A lack of instrumentation prohibits daily checks of scrubber pressure losses or scrubber gas temperatures. Prior to weekly start-up of the plant, spray nozzles and coke beds are checked. Nozzles have an average life of 2 to 4 months and are replaced at the rate of 6 to 12 weeks. Coke is added to any coke beds which appear to be depleted.

5.2 Recordkeeping

There is no performance data for the scrubbers due to a lack of instrumentation. Maintenance records consist of an accounting of parts purchased for the scrubbers. These records were unavailable at the time of the visit because the plant accountant was not at the plant. Labor devoted specifically to scrubber maintenance is not differentiated from other maintenance labor.

5.3 Emissions

Sources of emissions data for the scrubbers consist of estimates of maximum emissions submitted by the source for the permit application (see Section 3 of this report), one State conducted stack test for the sand dryer, and periodic State observations of scrubber plume opacities. Of these data, only the stack test contains information that can be used to quantify actual mass emissions.

Based on this one stack test, and on annual operation schedules for the plant, the smaller scrubber emits particulates at the approximate rate of 1368 lbs. per year. Uncontrolled emissions were not measured during this test. The control equipment engineer indicated that emissions violations were infrequent because it is plant policy to stop production when plume opacity violations are apparent. A low frequency of opacity violations reported by State inspectors confirms that violations are infrequent. A rough approximation of particulate emissions during the period August 1972 through December 1975 is shown in Figures 1 and 2.

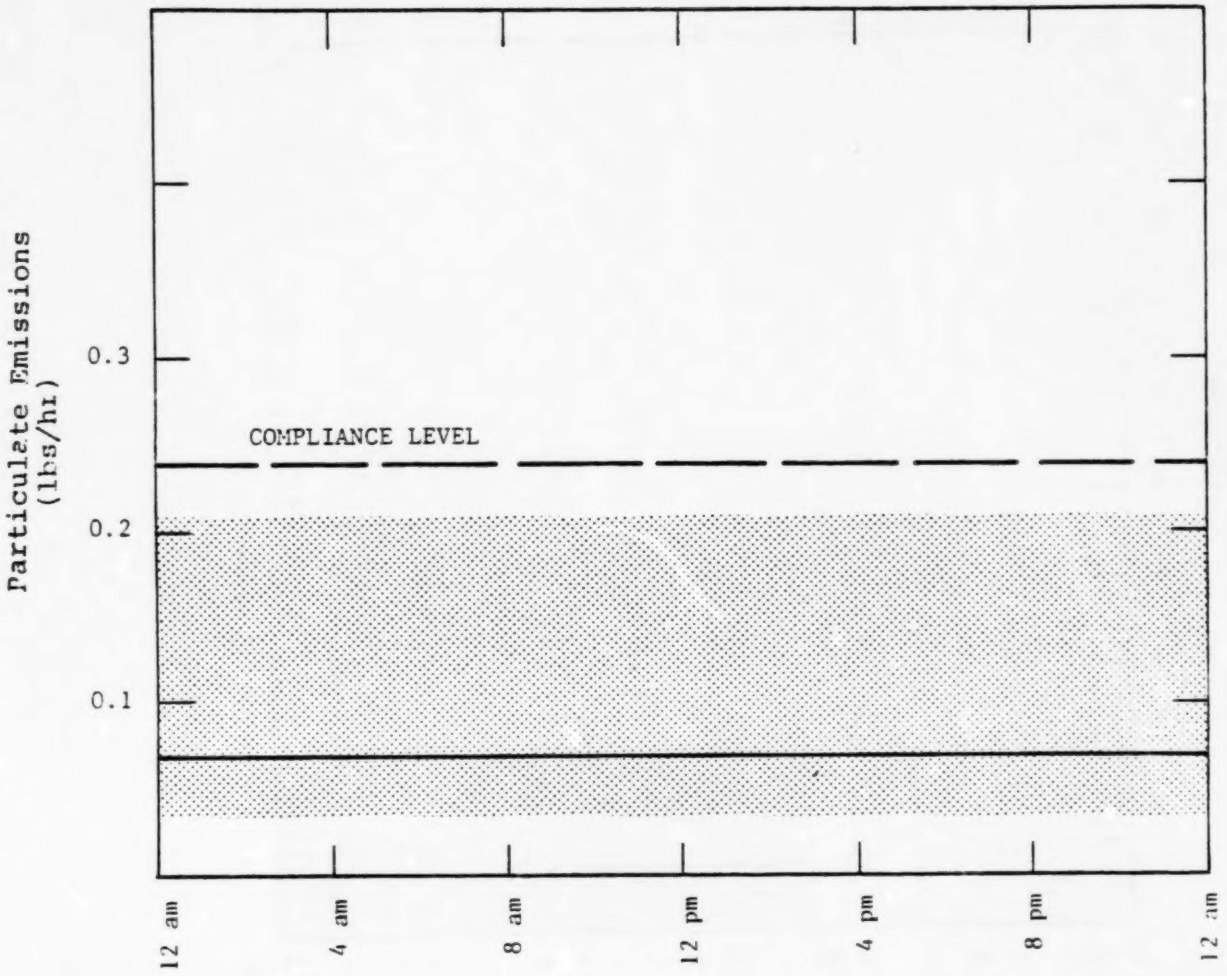
Emissions estimates submitted to the State with the permit application are not representative, because they are theoretical maximums. The emission rate measured during the State stack test indicated that actual emissions were less than 20% of the predicted maximum.

5.4 Spare Parts Inventory

The absence of the plant accountant during PEDCo's visit prevented the acquisition of a precise listing of spare parts. The control equipment engineer indicated that an ample supply of spray nozzles was kept on hand at all times. Coke packing consists of wood charcoal briquettes, which are readily available from local retail establishments. Thus far, scrubber operation has never suffered a lengthy interruption of service due to a lack of spare parts.

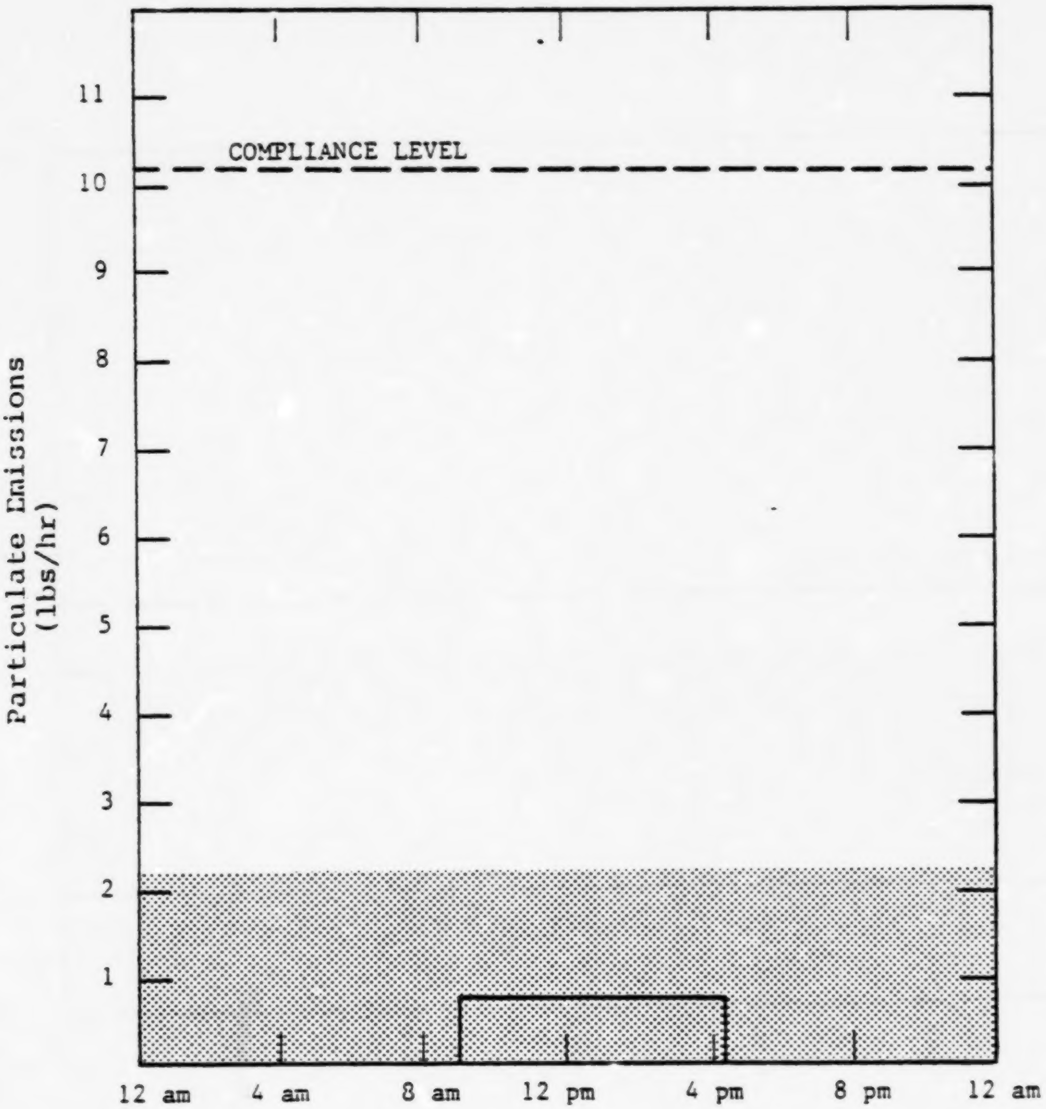
6. Costs

Cost data for the scrubbers was not available at the time of the visit. However, the control equipment engineer indicated that the scrubbers are an integral part of the production process. For this reason scrubber costs cannot be apportioned strictly to air pollution control. Prior to State involvement in air quality at the plant, emissions had been controlled for product recovery and for control of the work environment.



NOTE: This graph is highly speculative as there have been no stack tests and there are no operating records which can be used to extrapolate emissions rates.

Figure 2. Estimated Diurnal Emissions Profile for Source 15.



NOTE: Solid line represents best estimate of particulate emissions. Shaded areas represent the error range of the estimate.

Figure 2. Estimated Diurnal Particulate Emissions of Source 18.

INSPECTION REPORT

Source 19

1. Summary of Inspection

A shaker-type fabric filter system serving grinding and sawing operations was found to be in compliance with particulate mass emission and visible emission limitations. Internal inspection of the equipment indicated that all major components were in good working order. A review of plant records further indicated a low frequency of malfunctions and prompt repair of equipment. Results of this inspection demonstrate that a well conceived and implemented preventive maintenance program have a positive impact on excess emissions. This facility operates well below the required emission rate except for infrequent, unavoidable malfunctions.

2. Chronology of Source/Agency Interaction

1973 - August. Source applies for permit covering various sources at new plant. Apparent initial compliance with emissions regulations.

- October. Permit approved in 61 calendar days.

1974 - January. Inspection conducted to verify tax certification. All systems reported in compliance. Inspector noted excellent housekeeping practices.

1975 - December. Routine inspection conducted. Good maintenance program observed by inspector. No visible emissions. Plant engineer reports that unit to be rebagged in near future.

1976 - February. Routine inspection conducted. All bags replaced recently. Door on baghouse left open inadvertantly causing local fugitive dust problem. Plant manager issued memo to plant personnel reminding them of importance of closing baghouse access door after inspection.

- August. Routine inspection conducted. All equipment in excellent condition.

- November. Source applies for permit covering grinding and sawing operations plus several other relatively small sources.

- December. Permit requested by source approved in 17 calendar days. Standard recordkeeping and "good operations" stipulations included.

1977 - May. Routine inspection conducted. Plant engineer reports some bag dropping due to inadequate hanger design. Problem being corrected by plant maintenance personnel. This does not lead to an emissions problem, however, it does stress the remaining bags.

- October. Routine inspection conducted. Unit in compliance.

1978 - May. Routine inspection conducted. All sytems in compliance, however, one leaking bag found by inspector. Despite small leak, there were no visible emissions.

3. Plant Description

The plant produces extruded plastic pipe. The principal raw material is granular form PVC resin shipped from an associated plant located outside the State. Approximately 50 persons, including 5 professionals are employed at the plant. The operating schedule is 40 hours per week, 50 weeks per year. The plant and the air pollution control equipment are less than 5 years old.

There are five fabric filter systems. Four of these are small pulse jet units serving storage hoppers, and one is a moderate sized shaker type unit serving grinding and sawing operations. The latter unit is the subject of this report. It is located on an elevated platform adjacent to the main loading dock. Any visible emissions from this positive pressure fabric filter system would create a nuisance for persons in this area. The dust is extremely fine and highly colored.

4. Control Device Design Evaluation

The fabric filter system is designed to collect the PVC dusts generated by mechanical attribution in the grinding and sawing operations. Due to the characteristics of the material being handled and the temperature of the processes, vaporization and subsequent condensation of submicron fume is unlikely. Most of the particulate is probably in the plus 10 micron size range. Fabric abrasion can normally be expected with such particulate, however, bleeding is not as prevalent. The particulate is not sticky or oily, therefore, the probability of fabric bleeding is minimal.

The design air-to-cloth (A/C) ratio is 3.6 ft^2/Acfm. This is approximately 30 to 50% higher than normally encountered with shaker type baghouses handling this type of particulate. While this does not directly affect the particulate collection efficiency it should contribute to shorter than desirable bag life. The design gas flow rate to the baghouse is 12,000 Acfm at a temperature of 70°F. Cotton sateen bags, one foot diameter and 10 feet long are used. This is an appropriate choice considering the temperature and the type of cleaning employed. The bags are arranged in 12 rows of 8 bags each. The maximum "reach" required from the center aisle is four bags. While it is ideal to keep the "reach" to three bags, we believe that the layout of this unit is adequate for maintenance purposes. The bags are mounted from the top using the standard hooks and the bags are secured on the cell plate using clamps around the thimbles. Wear sleeves are not mounted in the thimbles and a deflection plate is not mounted in the baghouse inlet. In our opinion, it is an oversight not to include one or the other of these protectors considering the probable large particle size of the dusts handled. Generally bag abrasion is proportional to the square of the mass median particle size.

The design pressure drop across the baghouse is 3 inches water. Cleaning of the bags is done by intermittent shaking controlled by automatic timers. The collected dust falls into a hopper (60° angle of inclination) which is emptied continuously. This is a particularly important point since frequent operating problems can result from the practice of using hoppers for temporary storage.

Accessibility of the unit is excellent. It is located on a 20 foot high platform mounted immediately adjacent to the loading dock. The manometer and fan ammeter are panel mounted on the inner wall of the plant making it unnecessary to go outside to check the operation of the fabric filter.

5. Control Device Performance Evaluation

The unit has operated a period of four years without any serious problems. Due to the less than desirable bag life the company has dropped the gas flow rate to 9500 Acfm which reduced the effective A/C ratio to approximately 3.0. While this is still somewhat high for shaker fabric filter units, the company is now reporting acceptable bag life averaging 2 years.

Bag failures occur at a frequency of 1 to 2 per month. Most of these failures involve wear at the bottom of the cotton bag. It is conveivable that wear plates could minimize this problem.

The Company has reported some relatively minor problems with the bag hangers. During the first two years of operation, a number of bags dropped off the shaker assembly. This did not lead to an emissions problem since the bags blocked the gas entry at the tube sheet. There have also been some problems with bridging of particulate matter in the hoppers. Generally, the fabric filter was shut down for a short period of time in order to correct this problem. There is no bypass duct, therefore, the entire ventilation system is inoperative when the baghouse is down.

Our somewhat cursory internal inspection indicated that this unit is in excellent condition. Bag tension appear correct, there was no evidence of bleeding and there were no obvious deposits on the cell plate.

5.1 Preventive Maintenance

The Company adheres to an excellent preventive maintenance program which was designed by corporate engineering staff based on the vendors recommendations and in-house experience. Some of the items included on the check lists are specified below along with the frequency of occurrence:

Preventive Maintenance Schedule

Daily:
1. Bags; check for holes, leaks, and dry rot.
2. Controls; check pressure drop across manometer.
3. Ducts; check for leaking or plugging.
4. Clean air side; check for dust leaks.

Weekly:
1. Baghouse enclosure; check for weather tightness.
2. Bags; check for proper tension.
3. Shaker mechanism; check for loose bolts, worn bearings, condition of lubrication.
4. Hoppers and solids removal; check for proper operation, and leaks.
5. Controls; check timers, relays, and switch gear.
6. Clean air side; check for leaks.

Monthly:
1. Fans and drive; check impeller for wear, housing leaks, "V" belts, bearings, and pulleys.

2. Shaker mechanism; check belt drives.
3. Hoppers and solids removal; check drive chains, sprockets, and gear drive.

Annual: 1. Baghouse enclosure; check for condition of paint, condition of roof.

Implementation of the preventive maintenance program is done by means of work orders issued automatically according to the frequency specified above. The work orders itemize each task which is to be performed and the safety equipment which is necessary. The report sheets are in the form of simple checklists. Some instructions are included on the checklists to ensure that the inspection is complete and effective. A sample is attached.

In addition to the regular maintenance program, the plant engineer reported that special repairs are made as needed. Generally, malfunctions are noticed rapidly due to the location of the control device next to the normally populated loading dock and due to the highly colored nature of the dust. Malfunctions cannot be tolerated for extended periods due to the unsightly character of the dust.

In our opinion, the preventive maintenance program at this plant is excellent. The frequency and duration of excess emissions incidents is effectively minimized by this program. Furthermore, it is likely that this unit is not subject to the severe emission problems that can occasionally occur in other plants due to inadequate maintenance.

5.2 Recordkeeping

The Company maintenance foreman keeps the inspection reports on file as a record of the control equipment repairs. The pressure drop is not recorded, however, if it deviates from the standard value the baghouse is checked.

The recordkeeping procedures appear adequate for indicating the condition of the equipment and the possible need for repairs. Additional recordkeeping detail would probably not be cost effective.

5.3 Emissions

The uncontrolled emission rate for the grinding and sawing operations is estimated at 250 pounds per hour based on a 3 grains per Acfm inlet mass loading to the baghouse. At the standard control efficiency of fabric filter of 99.9%, the normal emission rate is less than 1 pound per hour. The required allowable emission rate according to the process weight regulation is approximately 10 pounds per hour, therefore, under normal operating conditions, the emissions are well below compliance requirements.

Emissions following a bag tear or other failure are probably in excess of the 10 pounds per hour level. It is impossible to accurately estimate these emissions without some knowledge of the extent and location of the tear. Since this data is obviously not available in an historical study such as this we are limited to a 'best guess' approach. As indicated on Figure 1 we have assumed that the peak emissions during bag failures are in the range of 2 to 20 pounds per hour. This estimate is subject to considerable inaccuracy. Using the upper value of 20 pounds particulate per hour and an assumed repair lag time of 2 hours, then the estimated excess emissions quantities per bag failure are 40 pounds. At a frequency of 2 bag failures per month, then the yearly total excess emissions are 0.5 tons. By a similar procedure, one can estimate the quantity of particulate which could legally be emitted but which is not during normal operation periods due to the high efficiency performance of the fabric filter. We calculate this emission "credits" value to be 9 tons per year. The latter result does not excuse the company for the excess emission incidents, however, it does provide some perspective to the adequacy of the control device performance over extended periods of times.

In judging the significance of the excess emissions values, we believe that the potential for ambient air quality standard violations and/or the nuisance potential should be considered. In this case, the emissions are too small and the location of the plant is too remote to cause either problem. Furthermore, the occurrence of malfunctions such as experienced at this plant is unavoidable. Additional regulatory requirements or more intense surveillance would probably not be effective and could potentially dilute the effort which the company now devotes to the maintenance of the control equipment.

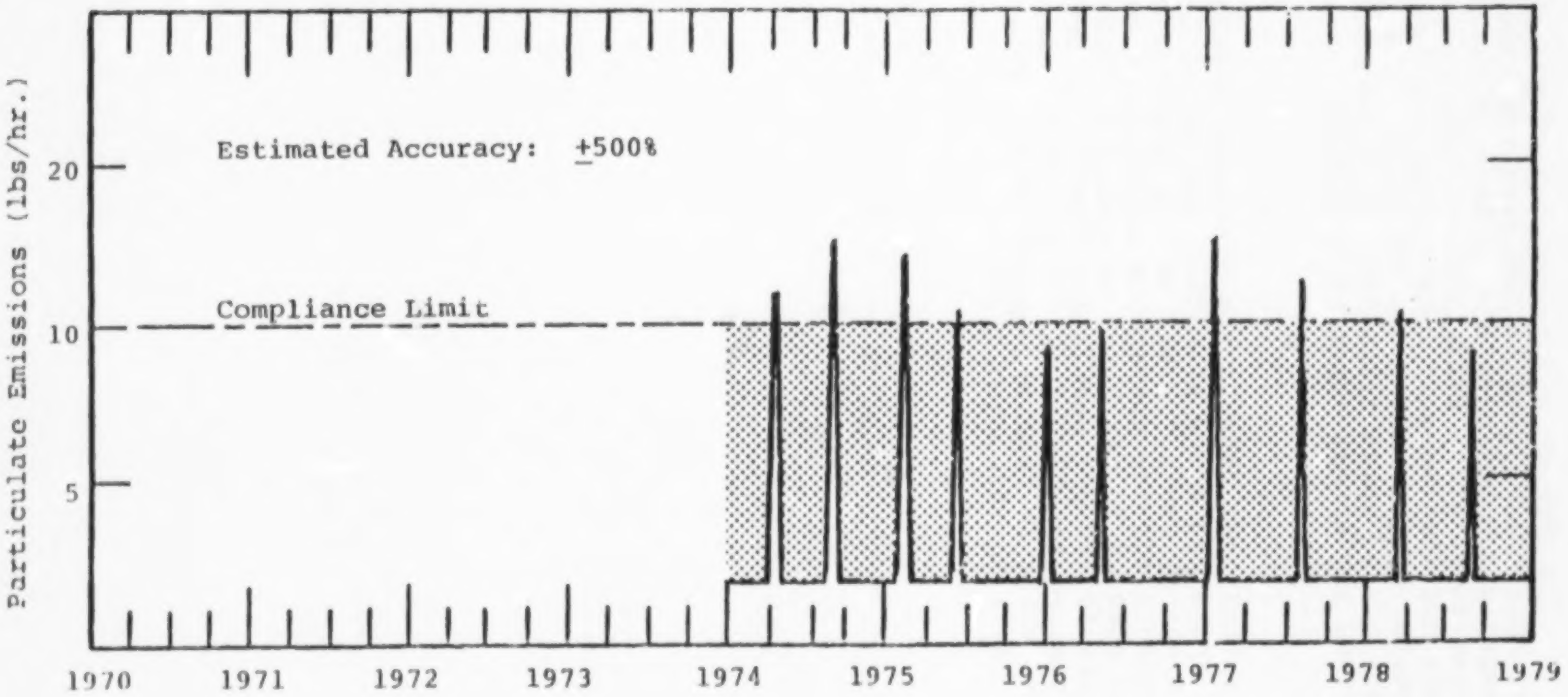


Figure 1. Estimated Particulate Emissions for Source 19.

5.4 Spare Parts Inventory

The Company maintains an adequate inventory of spare parts despite the fact that they have not experienced any problems to date in getting parts from suppliers. Parts kept on hand include but are not limited to: bags, rotary valve seals, belts, hangers and motor bearings. The unavailability of spare parts has not caused or aggravated any excess emission incidents.

6. Costs

Capital cost data is not presently available. The annual operating costs primarily consist of the labor and the energy costs. Based on the reported manhour requirements for the preventive maintenance work and an assumed cost of $8 per hour, we estimate that the labor costs are $3,500 per year. The electrical requirements are estimated roughly at $2,000 per year. Replacement of bags, which is required approximately once every two years, costs an additional $700.

INSPECTION REPORT

SOURCE 20

1. Summary of Visit

This fertilizer plant was visited to inspect the emission control system for the ammoniator - granulator operation. This control system consists of a dry cyclone for removal of coarse particulates, followed by a venturi scrubber/wet cyclonic separator for removal of fine particulates and ammonia fumes. Based on information obtained during the inspection and from State Agency files, it appears that the Source is in compliance nearly all of the time. Infrequent violations have been noted by the Agency in the form of objectionable ammonia odors. These violations have been short in duration, usually less than a few hours in length. Particulate violations apparently have not occurred. Plant management is genuinely concerned about emissions and it, therefore, attempts to maintain the control equipment in working order. The Source has a good relationship with the Agency and does not attempt to disguise any emission or control equipment problems from the Agency. The Source has been cooperative during routine inspection visits as well as during complaint investigations.

2. Chronology of Source/Agency Interaction

1970 - April. Agency visits Source to discuss control equipment plans.

1972 - January. Complaint received. Agency visits plant and finds process emissions in compliance - the problem is fugitive dust. A second visit reveals that the problem has continued. The Agency requests Source to present plans for corrective measures.

- April. Two complaints received. Agency responds with letters which explain steps the Source is taking to correct the problem.
- July. Temporary permit issued. Source given 7 months to reduce particulates at the granulator.
- August. Venturi scrubber is registered by the Agency.

1973 - April. Routine visit by Agency. Source is in compliance. Apparent initial compliance with emissions regulations.

1974 - September. Complaint received (ammonia fumes). Agency visits Source and suggests that ammonia operations be kept in better working order.

- December. Routine visit by Agency. Plant down for the season.

1975 - March. Source submits application for permit.

- June. Source inspected to evaluate scrubber. Permit issued.

- September. Routine visit by Agency. Plant down for the season.

- December. Routine visit by Agency. Plant in compliance.

1976 - February. Routine visit by Agency. Plant down for the season.

- April. Routine visit by Agency. Scrubber in compliance. (Other plant equipment is out of compliance for particulate emissions.)

- June. Agency visits to check problems with other equipment. Scrubber in compliance.

- November. Agency visits plant to inspect new equipment. Plant is down for the season.

1977 - January. Routine visit by Agency. Plant down for the season.

- March. Routine visit by Agency. Plant in compliance.

- April. Permit re-issued.

3. Plant Description

This Source produces granulated ammonium phosphate fertilizer at a rate of up to 50 tons per hour. Production begins with the reaction of phosphate, sulfuric acid, and ammonia in a brick lined reactor. The products of this reaction are mixed with a gypsum-acid slurry and introduced into a gas fired rotary ammoniator-granulator. Additional ammonia is added during this step, producing ammonium phosphate particles which agglomerate into granules. The granules are transferred into an oil-fired rotary dryer and then into a cooler. The cooled product is stored for transport.

The ammoniator-granulator produces ammonia fumes and up to 100 lbs/hr of ammonium phosphate particulates (particle size distribution is not known). Exhausts from the ammoniator-granulator pass through a dry cyclone, which collects coarse particulates for recycling. Exhausts from the cyclone pass through a long duct system to the venturi scrubber. The scrubber exhausts pass into an adjacent centrifugal separator for removal of water droplets, and the gases then pass to the stack. A centrifugal fan, located between the separator and the stack, induces draft in the system. Scrubber liquor that is collected by the centrifugal separator drains into an open top concrete holding vat. Here the liquor is neutralized with sulfuric acid and recycled to the phosphate reactor. Acid additions to the vat are controlled manually.

The venturi system has a capacity of more than 6,000 acfm @ 200°F. Although the ammoniator-granulator exhaust temperature can reach 200°F, the gases probably decrease in temperature during transit through the duct system to the venturi. There are no temperature gauges for monitoring venturi inlet or outlet temperatures. The venturi is constructed of fiberglass and has a 4½ inch diameter throat. The venturi is designed to develop a pressure differential of 18 inches of water, but there are no differential manometers or pressure gauges to measure this. The venturi uses up to 80 gallons of water per minute and has a predicted collection efficiency of 80%.

4. Control Equipment Design Evaluation

The control equipment design is well suited to the control requirements. Few changes could be made to improve its efficiency. The only two problems apparent are the lack of reliable pH control in the liquor vat and excessive duct wear immediately following the venturi.

Poor liquor pH control is the probable cause of the one citizen complaint about ammonia fumes. Liquor drained from the wet separator contains absorbed ammonia and has a high pH. If it is introduced into the holding vat without a concurrent addition of neutralizing acid, the ammonia fumes can re-enter the atmosphere. The fumes can become so offensive that plant personnel typically check the vat for odors several times per shift. When problems are suspected liquor pH is measured and acid flow is sometimes adjusted manually.

The occasional odorous emissions violations eminating from the liquor vat could be reduced or prevented entirely by the addition of an automatic pH control system.

During the visit evidence of chronic duct wear was observed near the venturi exhaust. The ducting at this point contains a small radius 90° elbow which causes gas flow to impact directly against one wall of the fiberglass duct. The duct has been patched at least once, indicating that there has been at least one control system failure because of duct wear. The duct should have been designed with a wider radius, thicker wall elbow at this point, or a replaceable impaction plate should have been incorporated into the design.

The centrifugal separator following the venturi does a good job of removing the liquor droplets from the gas. The fan appeared to be in excellent condition and did not vibrate, which indicates that demisting efficiency of the separator is high.

One other feature of the control system is worth noting. The relative locations of the ammoniator and the venturi separator required that extensive ducting be used. This problem was inherent in the plant arrangement and could not be avoided when the venturi was installed. The Source wisely designed the ducting so that it could be easily cleaned. Particulates that settle from the gases during the long transit to the venturi can be easily removed through clean-out hatches installed every 10 feet and at elbows. Ducting is cleaned during weekly plant shutdowns.

5. Performance Evaluation

5.1 Preventive Maintenance

The venturi system requires little preventive maintenance other than duct clean-out and monitoring of the liquor vat pH. As mentioned in Section 4, the ductwork is inspected during the weekly shutdown and cleaned if needed. The venturi is visited several times per shift to check for ammonia fumes and to check neutralizing acid flow. Also during these visits the fan operation is observed to check for vibrations, scrubbing water flow is visually checked, piping and ductwork is inspected for leaks, and the plume is observed for gross particulate emissions. The fan belts are usually inspected during weekly shutdowns.

5.2 Recordkeeping

No data is recorded for the scrubbers. This is due in part to the lack of instrumentation such as emissions monitoring devices, differential pressure gauges, fan motor ammeters, temperature indicators, and water flow meters. In addition, the State Agency has not asked the Source to submit any records despite a permit stipulation that authorizes the Agency to require them. As a result, no log book is maintained for scrubber operation.

It is doubtful that extensive recordkeeping would greatly improve the already good performance of the control equipment. However, the Agency should require a simple log book be maintained to record the hours that the equipment is operating; the dates, durations, and causes for any equipment malfunctions; and the results of any liquor pH tests.

5.3 Emissions

No stack tests have been conducted on the scrubber during the period of study. The State Agency has estimated that uncontrolled particulate emissions would be about 100 lbs/hr and that the equipment would be 80% efficient. These estimates seem plausible, although there is no test information to verify them. During the visit the system was operating properly and the plume was nearly invisible. Based on the above estimates and observations and on the absence of documented emissions violations in the Agency files, two emission profiles have been constructed. Figure 1 depicts the estimated annual emissions while Figure 2 depicts the estimated diurnal emissions. As shown in these estimated profiles, it is felt that the Source has been in continuous compliance since installation of the scrubber. The Plant Manager indicated that any major failure of the equipment would require immediate plant shutdown, because the resulting dust would create a problem in the working areas.

5.4 Spare Parts Inventory

Little in the way of spare parts is needed for the venturi system because components of the system rarely fail. The only moving parts in the system are the water pump and the fan. The Source has on hand one spare water pump and spare bearings and belts for the fan. The Source also

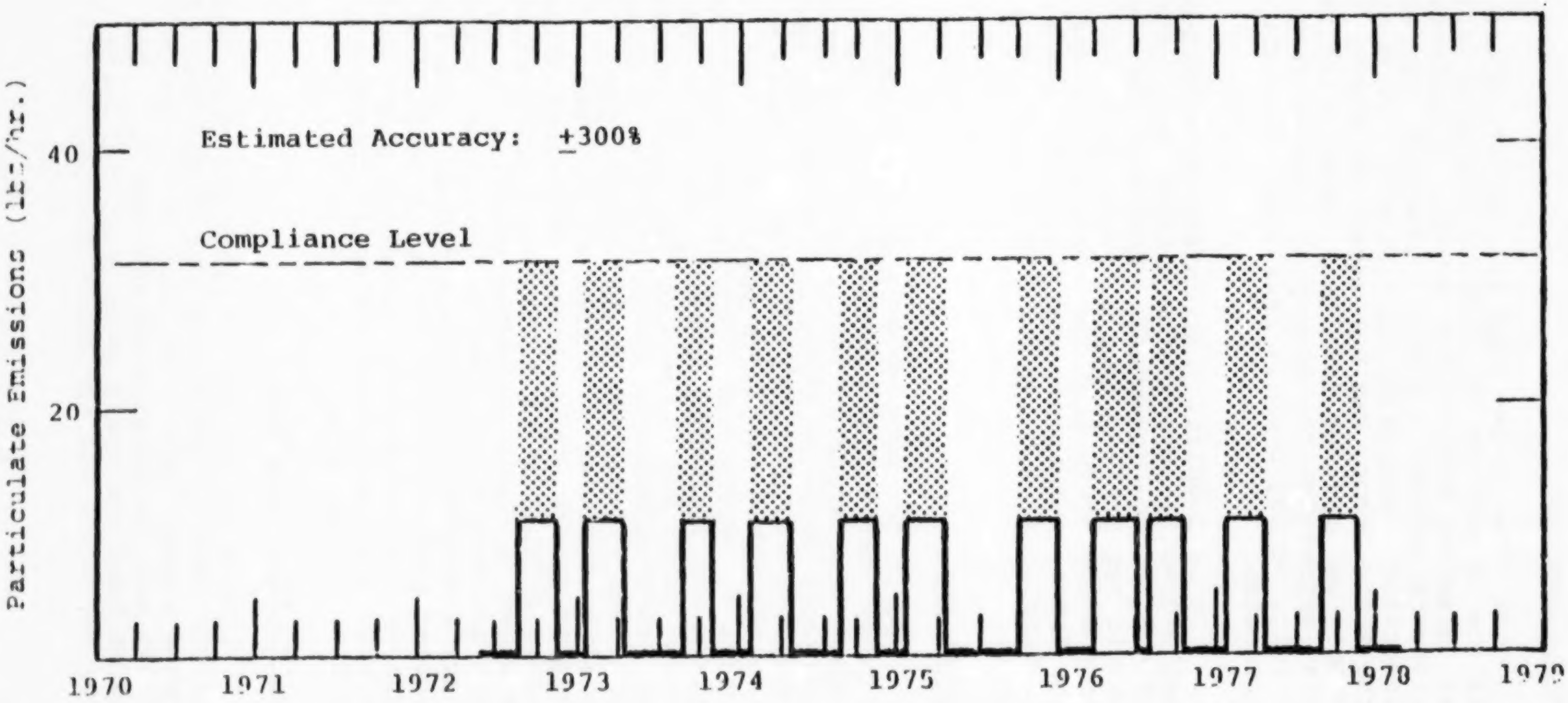
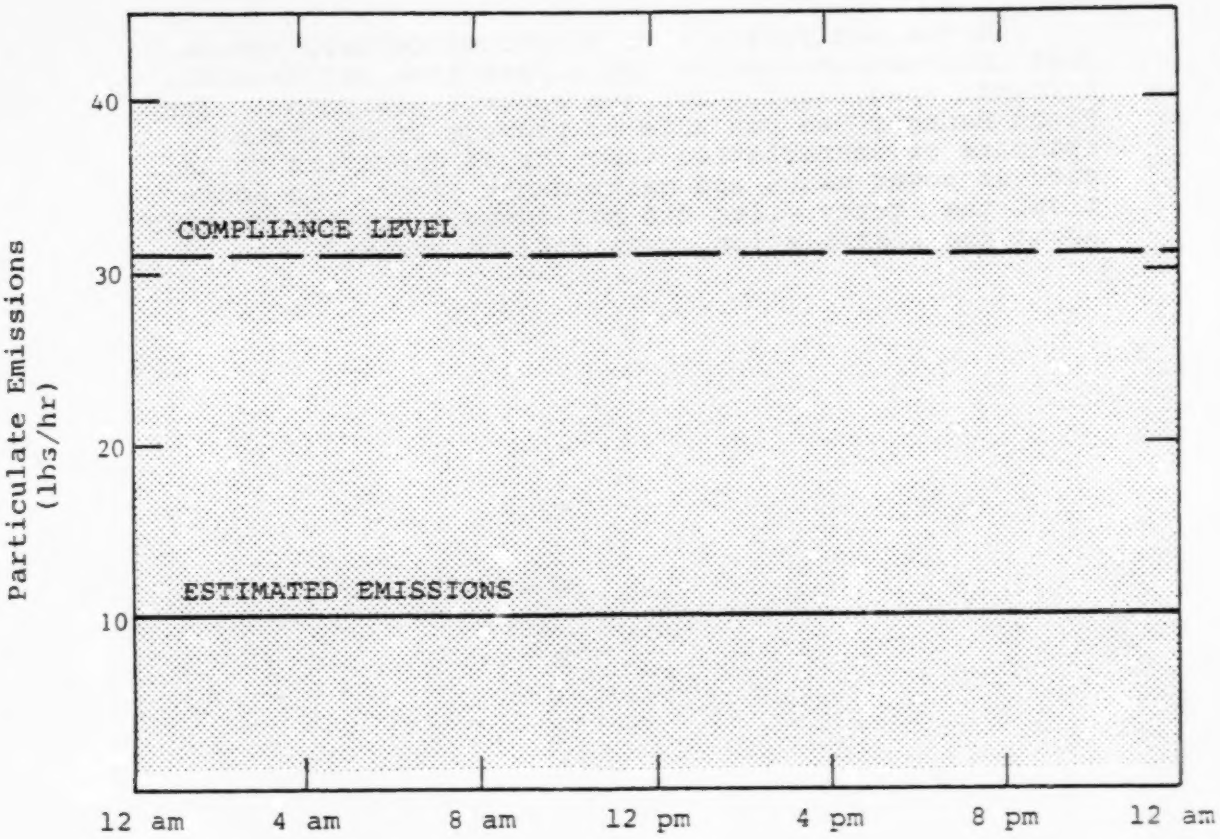


Figure 1. Estimated Particulate Emissions for Source 20.



NOTE: Shaded area represents the error range of the estimate. This graph is highly speculative as there have been no emissions tests performed on the equipment and there is no log book maintained for the equipment.

Figure 2. Estimated Diurnal Particulate Emissions of Source Number 20.

maintains a spare fan for the plant that fits the venturi system as well as other plant equipment.

6. Costs

It was not possible to construct control system cost information because the Source does not maintain accounts specifically for the control equipment. The Plant Manager was not able to provide an accurate estimate of installation costs or of operating costs such as power usage and maintenance labor. In addition, the Agency files did not contain any information about the installation costs for the system.

APPENDIX C

SAMPLE LETTER OF INTRODUCTION
SAMPLE POST-INSPECTION LETTER
SAMPLE TASK II CHECKLIST

PEDCo ENVIRONMENTAL
505 SOUTH DUKE STREET
SUITE 503
DURHAM, NORTH CAROLINA 27701
(919) 688-6338

October , 1978

LETTER OF INTRODUCTION

RE: Request to Visit Plant

Dear Mr.

PEDCo Environmental, under subcontract to Booz-Allen Hamilton, has initiated a study which is being co-sponsored by the Council of Environmental Quality (CEQ) and the U. S. Environmental Protection Agency (EPA). The overall purpose of this project is to evaluate the effectiveness of air pollution control programs in 9 selected states. PEDCo is conducting this study in the states of North Carolina and Texas. Other contractors are performing similar work in the other seven states.

We are specifically interested in the problems related to maintaining continuous compliance with air pollution control regulations. Accordingly, we hope to visit 30 sources in each state to obtain data concerning the maintenance procedures, costs, and the procedures followed by the agency and the source in the event of equipment malfunctions.

The involvement of the North Carolina Air Quality Section is limited to assisting PEDCo in identifying candidate sources. Data provided by to PEDCo will not be released to the North Carolina Air Quality Section unless you specifically request that this be done. PEDCo is evaluating sources that have had few problems in maintaining compliance and other sources which have had some difficulty in achieving and/or maintaining compliance. The North Carolina Air Quality Section has recommended your plant as a candidate for this study. Of particular interest is the operation and maintenance of the . According to the telephone contacts that have been made it is my understanding that our visit should occur about 1978 to be most convenient to you and your staff. We will confirm this date near the end of October.

Participation in this study is voluntary. PEDCo is seeking historical information (January 1970 to January 1978) and has no interest in the present compliance of the control equipment. The identities of the sources will not be revealed in the project report. Within the limitations of available data the report will include estimates of excursions above the applicable regulatory limits. Costs of maintenance and operation of control equipment will be estimated and we hope to identify good operating procedures as well as basic underlying problems.

This study is not related directly or indirectly to North Carolina or EPA enforcement programs. However, results of this study and concurrent projects may ultimately be considered by CEQ and EPA in the development of revised air pollution control strategies. Your participation in this study should contribute to a more realistic and objective evaluation of appropriate control strategies. Thank you for giving this request your consideration and if there are any questions, please do not hesitate in giving us a call.

Sincerely,

PEDCo ENVIRONMENTAL, INC.

Gary L. Saunders

Gary L. Saunders

cc: J. Wunderle, PEDCo
J. Wyman, Booz, Allen & Hamilton

GLS/dd

PEDCo ENVIRONMENTAL
505 SOUTH DUKE STREET
SUITE 503
DURHAM, NORTH CAROLINA 27701
(919) 688-6338

December , 1978

POST-INSPECTION LETTER

Dear Mr.

I would like to express our sincere appreciation for your assistance during our , 1978 visit to the plant. The information obtained during the visit will be helpful in performing an objective evaluation of the State's air pollution control program, the problems faced by industry and Agency personnel, and the present control strategies. The study is scheduled for completion in March 1979 and we will see that a copy of the study report is forwarded to you at that time.

As requested by , we are sending a copy of the draft of our inspection report for your plant. Please review this draft for completeness and forward any comments you may have to me. If you have any additional questions concerning this study or if we may be of assistance to you, please feel free to call me at the number listed above. Thank you again for your assistance.

Yours truly,

PEDCo ENVIRONMENTAL, INC.

John Richards

John R. Richards

JRR/dd

Attachments

cc:
J. Wunderle, PEDCo Environmental
J. Wyman, Booz, Allen & Hamilton

TASK II (P/N 3374) (1/16)

SOURCE INFORMATION CHECKLIST

I Source Identifier

Category:

	Source	Agency (Local Field Office)
Name:	____________________	____________________
Location:	____________________	____________________
	____________________	____________________
Contact:	__________ Phone __________	__________ Phone __________

II Permit Information

(single)(multiple) permits

II-A Permit Identifier

Actions and Dates, etc.

PERMIT HISTORY

			AGENCY			SOURCE ACCEPTANCE		
Permit No.	Regulated Emission (PM, SOx, NOx, HC)	Source Description (Boiler, Kiln, etc)	Date Rec'd	Date of Final Action	Expiration Date	Yes	No	Appealed[a]

[a] - If appealed - give details, results on ADDENDA sheets.

(2/16)

II-B **Permit Terms** Emission Limits (from Regulation/permit); calculated (specified) allowable emissions, etc.

Permit No	Emission Limit	Allowable Emissions lb/day[a]	CONTROL STRATEGY DESCRIPTION/OTHER REMARKS: (Ex: ESP, low sulfur coal, etc.)

---

[a] Give basis under remarks - i.e., basis full or % production; 24 hour - 365 day operation or other. etc.

II-C **Permit Terms:** Briefly state control strategy, key compliance schedule steps (as design, order of equipment, equipment installation, operation, compliance test, etc.), due dates, actual completion dates and associated costs - capital and annualized O/M costs over specified years.

PERMIT SPECIFIED CONTROL STRATEGY/COMPLIANCE SCHEDULE:

Permit No.	Control Equipment	Milestone Steps	Due Date	Actual[a] Completion Date	COSTS $x10	
					Capital	O/M by year

[a] - If completion date was overdue - describe reason, sanctions (?), etc. in ADDENDA.

(4/16)

II-D **Permit Terms:** Special Terms and Conditions (as monitoring, reporting requirements - describe, give costs of capital, yearly O/M), etc; list information on source performance in implementing, etc.

Permit No.	Special Terms/Conditions Provisions

(5/16)

II-E Permit History (Chronology) Produce a chronology of permit modification/renewal/status change, etc.

Permit No.	Change date	Description of reason for changes made, source reaction to, implementation due date, actual date of completion, costs, etc.

III Modifications Affecting Emissions (6/16)

Record and describe by date and quantify the emission reduction/increase occasioned by the change, the duration of such change (dates); etc. (Example: Changes in raw material or fuel, production rates, product mixes, etc.) Estimate any associated change in costs.

Permit No	Date	Narrative

(7/16)

IV-a **Field (Compliance) inspection Reports:**
Distinction is made between "routine scheduled inspections (RSI)" and "special cause inspections (SCI)". Indicate results as compliance (C) or non-compliance (NC).

Permit No	Year	Number				Remarks: (Reason for special inspection or other pertinent information.)
		RSI		SCI		
		C	NC	C	NC	

(8/16)

IV-b **Field (Compliance) Inspection Reports** (Chronological history): For those instances of non-compliance (see IV-a) - briefly describe report results, degree of non-compliance, resultant agency action required of source, source response, timeliness of implementation, agency follow-up, sanctions, associated costs (capital; O/M by year),etc.

Permit No.	Date	Narrative

(9/16)

V **Source Test Information:**

Record reason for tests, test results (compliance vs. non-compliance and quantify); resultant actions required by agency; source response; agency follow-up; sanctions; costs (capital and O/M yearly), etc. (State test method used)

Permit No.	Date of Test	Narrative

(10/16)

VI Malfunction Reports:

State cause; avoidable/unavoidable; reported by source or other; voluntary or required reporting; actions taken by agency and/or owner; voluntary action or imposed by agency; action results; timeliness; costs, etc.

Permit No.	Date	Narrative

IX **Specific Questions:**

1. Understanding of compliance/non-compliance with permit conditions:

Response (Agency/Source): ____________________

2. Instances of non-compliance during construction phase (give average in days, reasons, sanctions, permits modified because of, action taken, etc.)

Response (Agency/Source): ____________________

3. Instances of non-compliance during operating (continuing compliance) phase, nature of non-compliance, frequency, corrective measures, sanctions by source (self-imposed on own personnel) or agency imposed, nature of, results, costs.

(12/16)

VIII Litigation/Legal Enforcement Record

Chronologically list enforcement actions, nature of, results, agency and source actions, timeliness, costs, etc.

Permit No.	Date	Narrative

ADDENDA:

Use to supplement insufficient space for previous pages (Items I through IX) OR to add supplemental information of value and not addressed herein. Reference appropriately.

Reference	Supplemental Information

IX **Specific Questions (Cont'd).**

4. If not in continuing compliance (intermittent compliance) - views regarding causes of non-compliance (as achievable technology limitation vs emission limit; equipment or spare parts availability, O/M budget restraints, etc.).

Response (Agency/Source):

5. If not in compliance - additional requirements/controls that would achieve compliance and associated additional capital and annual O/M costs to attain compliance.

Response (Agency/Source):

IX **Specific Questions (Cont'd).**

6. Suggestions that would improve the effectiveness of the regulatory process: (as modification of compliance/non-compliance determination; manner sanctions are imposed; etc.)

Response (Agency/Source): ____